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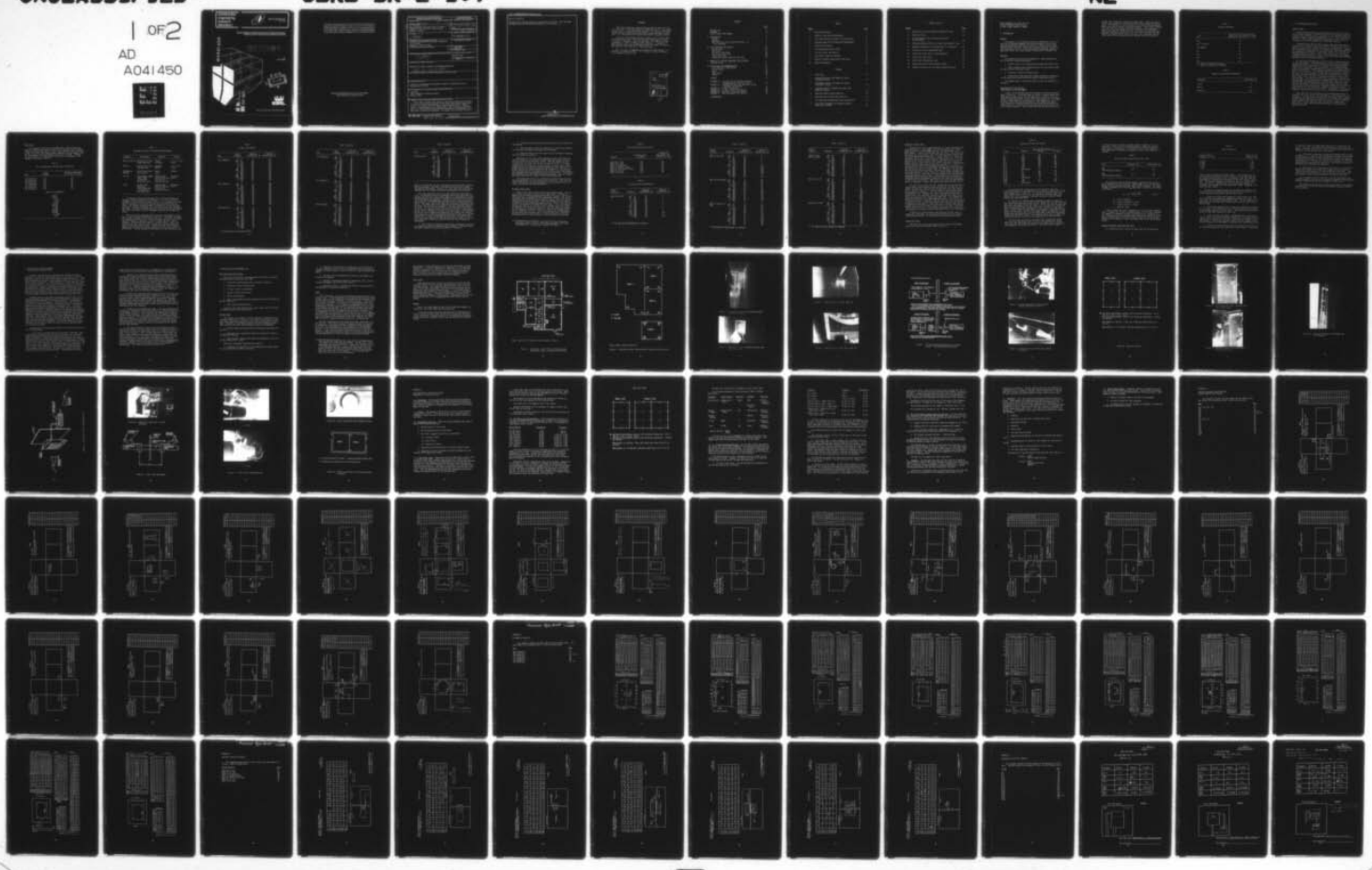

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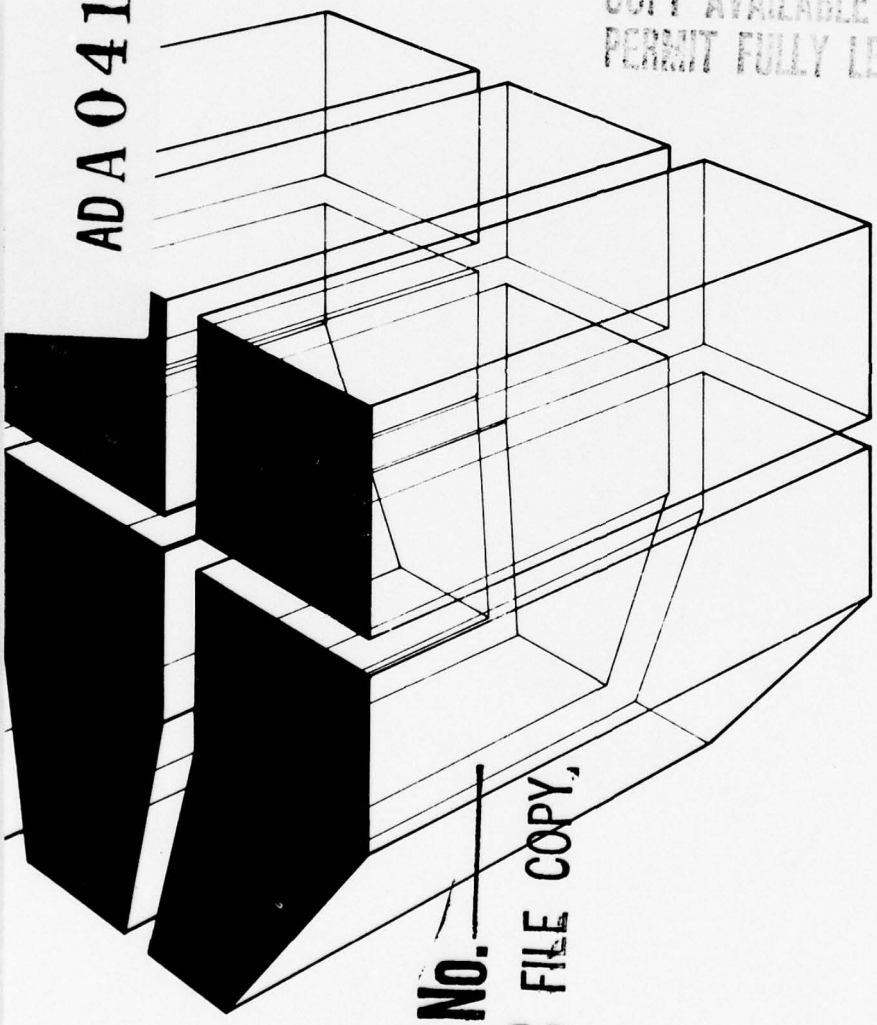
SPECIAL REPORT E-107
June 1977

RADIO FREQUENCY SHIELDING TESTS OF SYSTEM TECHNOLOGY TEST FACILITY AT MECK ISLAND, MARSHALL ISLANDS



by
P. H. Nielsen

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This report presents the results of tests and inspections performed to verify the shielding integrity of the newly constructed Systems Technology Test Facility (STTF) on Meck Island, Kwajalein Atoll, Marshall Islands. Recommendations for improvement of the structure's effectiveness, including suggested maintenance techniques and recommendations for additional testing, are presented. The report also evaluates the radio

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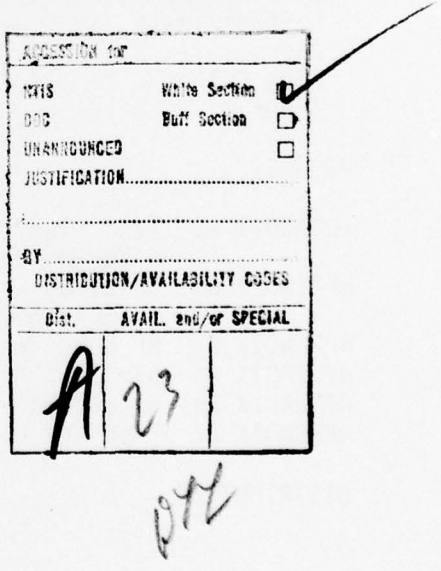
frequency (RF) shielded enclosure leak detection (sniffer) test technique for determining the shielding performance of a structure.

FOREWORD

This test program was conducted for the Pacific Ocean Division, U.S. Army Corps of Engineers under IAO #PODSP-MIL-76T-32. The project monitor was A. T. Bolt, Huntsville Division. The task was performed by the Electrical-Mechanical Branch (EPM), Energy and Power Division (EP), U.S. Army Construction Engineering Research Laboratory (CERL).

The tests were conducted between 16 August and 15 October 1976 by two CERL test teams. The first test team consisted of W. Ford, D. Hannum, R. Racioppi, and H. Stringfellow. The second test team consisted of J. Hall, D. Hannum, and P. Nielsen. J. Kauanoe of Martin-Zachry Construction provided valuable assistance in location and layout of test items and in conducting tests.

COL J. E. Hays is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director. M. J. Pollock is Chief of EPM and R. G. Donaghy is Chief of EP.



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RADIO FREQUENCY SHIELDING TESTS OF
SYSTEM TECHNOLOGY TEST FACILITY
AT MECK ISLAND, MARSHALL ISLANDS

1 INTRODUCTION

Purpose

The purpose of the inspections and tests documented in this report was to determine whether the shielding integrity of the newly constructed Systems Technology Test Facility (STTF) on Meck Island, Kwajalein Atoll, Marshall Islands met the specifications. The tests were conducted by two U.S. Army Construction Engineering Research Laboratory (CERL) test teams between 16 August and 15 October 1976.

Approach

As proposed by the test plan (Appendix A), CERL evaluated the STTF using the following techniques:

1. Sniffer tests of all accessible weld seams and floor drains

2. Radio frequency (RF) attenuation tests of the shielded doors, air duct filters, and pipe filters

3. Electrical filter and conduit tests

4. Inspection of the electrical conduit system for conformance to the construction specification and good RF shielding practice.

The methods used in the various types of tests are detailed in Chapter 2.

Description of Facility and Installation of Test Equipment

Figure 1 is the ground floor plan showing the various shielding zones of the STTF. The second floor or turret is located essentially above room 109 and is also in shielding Zone A. Tables 1 and 2 list the shielding requirements for the zones, which result from continuous welded 11-gauge steel liner plates on all zone boundaries. RF shielded doors allow personnel and equipment to pass between the zones. Test connections to external points on each shielding zone were provided (Figure 2) to permit direct application of RF test signals to the shielded structure. These signals provided the excitation for RF

sniffer tests conducted inside the shielded zones. Electrical power filters were provided to isolate electrical lines between the shielded zones. In addition, air duct and pipe filters were installed wherever these items passed through a shielding boundary. Large panels in Rooms 107, 108, 109, and 110 were opened to allow entry of the equipment modules and were then welded in place to complete the shielding liner. With the exception of these welds, all the liner plate seams had been magnaflux inspected before any sniffer tests were conducted; any defects found in these inspections were repaired during construction.

Table 1

Required Shielding

Zone*	Electrical Field and Plane Wave Attenuation, dB (10 kHz to 7 GHz)
A-B	48
A-D** (turret)	78
A-D (other)	75
A-C	59
B-C	48
B-D	48
C-D	67

* Zones are defined in Figure 1.
** Zone D is outside the building.

Table 2

Magnetic Field Shielding Required

Frequency	Attenuation, dB
60 Hz	6
400 Hz	20
1-10 kHz	40

2 TEST PROCEDURES AND RESULTS

Sniffer Tests

In RF shielded enclosure leak detection system (sniffer) tests, the shielded structure is externally excited from diagonally opposite corners with a 100-kHz signal. Any defect in the structure which can cause RF leakage produces a nonuniformity in the current flow on the structure. This current nonuniformity produces a field inside the structure which can be measured with a hand-held detector.

A Stoddard Model 900 Shielded Enclosure Leak Detection System consisting of a signal source and a separate hand-held receiver (Figure 3) was used for the sniffer tests in this investigation. Since a defect parallel to the direction of current flow might not be detected by a system with connections in only two corners, each shielded zone was provided with two sets of connections (Figure 4) to two sets of diagonally opposite corners. Thus, a leak undetected by one connection would be discovered by the other, and a leak could have different measured values for the two connections.

All accessible welded seams of the STTF were sniffer-tested during the test program. Perforated metallic sound insulation material covering considerable portions of the walls and ceilings prevented examination of the seams which were covered. The perforated metal itself can be expected to improve the structure's shielding; however, controlled laboratory testing should be conducted to quantify the effects of this material. The covered areas were scanned with the sniffer at 1-ft (0.3 m) intervals for both sets of connections, except for those few locations where the wall was inaccessible due to equipment placed close to the wall. No leaks were found in any of the covered areas. The areas surrounding the inaccessible locations were also scanned, and no indications of leakage were found. Thus, it is unlikely that any undetected leaks exist in these locations. Doors 109 (exterior) and 201 (exterior) and three of the eight side sections of the antenna array at the interface between the array and the building were also sniffer-tested. Appendix B presents the data sheets for the sniffer tests of the STTF. The numbers in the "levels" column on the data sheets are the sniffer readings before rewelding.

Leaks were found on the mounting of the welded panel doors in rooms 109 and 110 in Zone A, and the floors in area 103 and room 115 in Zone C. The leaks found by the sniffer tests were marked, repaired by rewelding the defects, and retested until no leakage was detected. Figures 5 and 6 show repairs on the floor liner in room 115 and the lower corner of the large panel door in room 110, respectively. Figure 6 also shows some of the perforated metal sound insulation mentioned earlier.

Door Tests

RF attenuation tests of the shielded doors (Table 3) were conducted according to the methods specified in National Security Agency (NSA) Specification No. 65-6. Figure 7 shows the test setup specified by NSA. The tests below 1000 Hz were conducted using the method shown for the magnetic field measurements from 1 kHz to 10 MHz. Although the test procedure is essentially the same at all frequencies, the equipment used varies (Table 4).

Table 3

STTF Shielded Doors and Door Test Frequencies

Door	Zone Boundary	Shielding Requirement, dB (10 kHz to 7 GHz)
103 (Interior)	C-D	67
109 (Interior)	A-C	59
109 (Exterior)	A-D	75
111 (Interior)	B-C	48
111 (Exterior)	B-D	48
125 (Exterior)	C-D	67
201 (Exterior)	A-D	78

Door Test Frequencies

60 Hz
400 Hz
1 kHz
4.5 kHz
9 kHz
10 kHz
200 kHz
1 MHz
10 MHz
100 MHz
500 MHz
2.5 GHz
7 GHz

Table 4

Equipment Used for RF Attenuation Measurements

Frequency	Transmitter	Receiver	Antenna
60 Hz to 10 kHz	Wavetek Oscillator Bogen Amplifier	HP400E Voltmeter	22 in. (0.6 m) Loops
200 kHz	Wavetek Oscillator ENI Amplifier	Stoddard NM12AT	1-ft (0.3m) Loops
100 MHz and 500 MHz	GR Unit Oscillator Type #1208-A	Empire NF105	Dipoles
2.5 GHz	Narda Model 18500B Power Pulser Ailtech 445 Power Oscillator	Tektronix 491 Spectrum Analyzer Ailtech 707 Spectrum Analyzer	Microwave Horns
7 GHz	Hp 693 Signal Generator Alfred Model 506 Traveling Wave Tube Amplifier	Tektronix 491 Spectrum Analyzer Ailtech 707 Spectrum Analyzer	Microwave Horns

A reference reading was obtained with no shielding between the antennas, which were spaced at a distance of 2 ft (0.6 m) plus the thickness of the shielding (Figures 8 and 9). The transmitting system was then located on one side of the door and the receiving on the other. The antennas were positioned in sequence at the various door test points (Figures 10 through 12), and the received signal strength was noted. A second reference reading was taken after the measurements were made on the door to verify equipment operation and control settings.

The ratio of the reference level to the test measurement in decibels is the shielding effectiveness of the door. The lowest shielding effectiveness obtained at any test position was reported as the shielding effectiveness of the door. Table 5 presents the test results. Appendix C contains the data sheets for the door tests. Doors 109 (exterior) and 201 (exterior) did not meet the required attenuation specifications when first tested. Inspection of door 201 (exterior) showed that the fingerstock gasket material did not extend to one of the corners. This was brought to the attention of the contractor, the

Table 5

RF Door Test Results

Door	Test Frequency	Required Attenuation, dB	Measured Attenuation, dB
103 (Interior)	60 Hz	6	19+
	400 Hz	20	33+
	1 kHz	40	40+
	4.5 kHz	40	45+
	9 kHz	40	64+
	10 kHz	40	67+
	200 kHz	67	70+
	1 MHz	67	70+
	10 MHz	67	70+
	100 MHz	67	80+
	500 MHz	67	70+
	2.5 GHz	67	70+
	7 GHz	67	70+
109 (Interior)	60 Hz	6	29+
	400 Hz	20	40+
	1 kHz	40	45+
	4.5 kHz	40	49+
	9 kHz	40	56+
	10 kHz	40	59+
	200 kHz	59	70+
	1 MHz	59	60+
	10 MHz	59	60+
	100 MHz	59	60+
	500 MHz	59	60+
	2.5 GHz	59	60+
	7 GHz	59	60+
109 (Exterior)	60 Hz	6	14
	400 Hz	20	24
	1 kHz	40	30
	4.5 kHz	40	40
	9 kHz	40	--*
	10 kHz	40	47
	200 kHz	75	76
	1 MHz	75	81
	10 MHz	75	82
	100 MHz	75	79
	500 MHz	75	79
	2.5 GHz	75	86
	7 GHz	75	73

* The 9-kHz test was omitted by error.

Table 5 (Cont'd)

Door	Test Frequency	Required Attenuation, dB	Measured Attenuation, dB
111 (Interior)	60 Hz	6	23
	400 Hz	20	30
	1 kHz	40	46
	4.5 kHz	40	52
	9 kHz	40	54
	10 kHz	40	58
	200 kHz	48	72
	1 MHz	48	90+
	10 MHz	48	60+
	100 MHz	48	60+
	500 MHz	48	70+
	2.5 GHz	48	60+
	7 GHz	48	50+
111 (Exterior)	60 Hz	6	20
	400 Hz	20	28
	1 kHz	40	41
	4.5 kHz	40	44
	9 kHz	40	54
	10 kHz	40	52
	200 kHz	48	55+
	1 MHz	48	60+
	10 MHz	48	60+
	100 MHz	48	60+
	500 MHz	48	70+
	2.5 GHz	48	70+
	7 GHz	48	60+
125 (Exterior)	60 Hz	6	15+
	400 Hz	20	32+
	1 kHz	40	40+
	4.5 kHz	40	49+
	9 kHz	40	67+
	10 kHz	40	67+
	200 kHz	67	90+
	1 MHz	67	110+
	10 MHz	67	80+
	100 MHz	67	90+
	500 MHz	67	80+
	2.5 GHz	67	95+
	7 GHz	67	80+

Table 5 (Cont'd)

Door	Test Frequency	Required Attenuation, dB	Measured Attenuation, dB
201 (Exterior)	60 Hz	6	14
	400 Hz	20	29
	1 kHz	40	36
	4.5 kHz	40	43
	9 kHz	40	50
	10 kHz	40	52
	200 kHz	78	74
	1 MHz	78	94
	10 MHz	78	86+
	100 MHz	78	94
	500 MHz	78	93+
	2.5 GHz	78	100
	7 GHz	78	73+

defect was corrected, the door and fingerstock were cleaned, and the door was retested. The door's attenuation characteristics showed considerable improvement. However, at 1 kHz, where the shielding was improved from 33 to 36 dB, the 40-dB requirement was not attained.

Door 109 (exterior) also did not meet the 40-dB requirement at 1 kHz. Considerable effort was expended cleaning and drying the fingerstock and the door's knife edge; however, no improvement in shielding effectiveness was obtained. Problems with the door may be due to the relatively large temperature gradient to which it was subjected; the building's air conditioning kept the interior temperature at 60°F (16°C). The rubber seal on the door did not prevent considerable condensation from existing on the bottom of the door and frame system at all times. No corrosion was evident on the gold-plated fingerstock for this door. However, slight corrosion was visible in the mounting channel for the fingerstock located on the door frame. The contractor was not willing to remove the fingerstock for cleaning this surface, since there was no spare gold-plated fingerstock at the site, and the fingerstock is subject to breakage during removal and installation. Since it was not feasible for the CERL test team to remain at the site until additional fingerstock could be procured, the following was recommended:

1. Upon receipt of additional gold-plated fingerstock, the existing fingerstock should be removed, and the channel in the door frame thoroughly cleaned to remove any oxidation or corrosion.

2. A conductive grease should then be applied to the surfaces of the channel.

3. The fingerstock should be cleaned with a solvent and checked for corrosion or damage and replaced in the channel.

4. The knife edge of the door should also be cleaned and treated with the conductive grease.*

Additional sniffer tests were conducted on doors 109 (exterior) and 201 (exterior) to provide a limited comparison between illumination test data and sniffer test results. The data sheets for the sniffer tests for Rooms 109 (12 and 13 October) and 201 (13 October) in Appendix B (pp 57-59, 71) give the results of these tests. Spot checks of door 125 (exterior) showed considerably lower leakage (0 to 15 dB) than that of 109 (exterior) and 201 (exterior). Door 125 (exterior) had passed the RF attenuation test earlier, and visual inspection indicated that the fingerstock was in good condition. The data are too limited to draw significant conclusions; however, they do indicate that the sniffer may be a useful tool for door inspection.

The fingerstock on door 111 (interior) had deteriorated considerably through normal use by 2 October 1976 (Figure 13). This door receives considerable use, and maintenance will be necessary for it to retain satisfactory shielding performance.

Air Duct Filter Tests

Table 6 lists the air duct filters and shielding zones. The air duct filter tests were similar to the RF door tests. A reference reading with no shielding between the antennas was taken; the air duct filter was then illuminated by the transmitting antenna. The receiving antenna was positioned on the opposite side of the filter and the received signal level was noted. The ratio between the two signals in decibels is the measured attenuation level. Table 7 lists the test results, and Appendix D presents the data sheets. The test frequencies were the same as for the door tests, although some filters were not tested at all frequencies because of the size limitation imposed by the dimensions of the air duct; i.e., some of the antennas would not fit inside the air duct. The filters passed at all frequencies at which they were tested; there is no reason to believe that their performance would be unsatisfactory at the frequencies not tested.

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* The manufacturer of the door, Universal Shielding Corporation, recommends Chomerics 4210 or 4220 conductive grease (available from Chomerics, 77 Dragon Court, Woburn, MA 01801).

Table 6

STTF Shielded Air Duct Filters

Location	Shielding Zone Boundary	Attenuation Requirement, dB (10 kHz to 7 GHz)
Room 108 to 109	A-C	59
Room 111 to 125c	B-C	48
Room 114 to Outside	C-D	67
Room 111 (open) to Roof	B-D	48
Room 111 (air duct) to Roof	B-D	48
Room 111 to 110	A-B	48
Room 110 to 125c	A-C	59

Table 7

Air Duct Filter Test Results

Filter Location	Frequency	Required Attenuation, dB	Measured Attenuation, dB
Room 108 to 109	60 Hz	6	*
	400 Hz	20	*
	1 kHz	40	*
	4.5 kHz	40	*
	9 kHz	40	*
	10 kHz	40	*
	200 kHz	59	*
	1 MHz	59	*
	10 MHz	59	*
	100 MHz	59	*
	500 MHz	59	60+
	2.5 GHz	59	*
	7 GHz	59	60+

* Air duct not large enough for antennas.

Table 7 (Cont'd)

Filter Location	Frequency	Required Attenuation, dB	Measured Attenuation, dB
Room 111 to 125C	60 Hz	6	*
	400 Hz	20	*
	1 kHz	40	*
	4.5 kHz	40	*
	9 kHz	40	*
	10 kHz	40	*
	200 kHz	48	70+
	1 MHz	48	64+
	10 MHz	48	50+
	100 MHz	48	70+
	500 MHz	48	60+
	2.5 GHz	48	*
	7 GHz	48	50+
Room 114 to Outside	60 Hz	6	30
	400 Hz	20	60
	1 kHz	40	69
	4.5 kHz	40	72
	9 kHz	40	76
	10 kHz	40	74
	200 kHz	67	88+
	1 MHz	67	70+
	10 MHz	67	70+
	100 MHz	67	70+
	500 MHz	67	70+
	2.5 GHz	67	70+
	7 GHz	67	70+
Room 111 (open) to Roof	60 Hz	6	35
	400 Hz	20	44
	1 kHz	40	49
	4.5 kHz	40	53
	9 kHz	40	54
	10 kHz	40	52
	200 kHz	31	85+
	1 MHz	31	70+
	10 MHz	31	70+
	100 MHz	31	80+
	500 MHz	31	80+
	2.5 GHz	31	70+
	7 GHz	31	60+

* Air duct not large enough for antennas.

Table 7 (Cont'd)

Filter Location	Frequency	Required Attenuation, dB	Measured Attenuation, dB
Room 111 (air duct) to Roof	60 Hz	6	50+
	400 Hz	20	56+
	1 kHz	40	63+
	4.5 kHz	40	71+
	9 kHz	40	76+
	10 kHz	40	52+
	200 kHz	31	85+
	1 MHz	31	70+
	10 MHz	31	60+
	100 MHz	31	60+
	500 MHz	31	60+
	2.5 GHz	31	70+
	7 GHz	31	70+
Room 111 to 110	60 Hz	6	*
	400 Hz	20	*
	1 kHz	40	*
	4.5 kHz	40	*
	9 kHz	40	*
	10 kHz	40	*
	200 kHz	48	85+
	1 MHz	48	60+
	10 MHz	48	70+
	100 MHz	48	60+
	500 MHz	48	60+
	2.5 GHz	48	60+
	7 GHz	48	50+
Room 110 to 125C	60 Hz	6	24+
	400 Hz	20	46
	1 kHz	40	48
	4.5 kHz	40	60+
	9 kHz	40	65
	10 kHz	40	63
	200 kHz	59	85+
	1 MHz	59	60+
	10 MHz	59	70+
	100 MHz	59	70+
	500 MHz	59	70+
	2.5 GHz	59	70+
	7 GHz	59	60+

* Air duct not large enough for antennas.

Electrical Filter Tests

The electrical filters were subjected to a test developed by the White Sands Missile Range (WSMR) Facilities Acceptance Test (FACT) team for tests at the SAFEGUARD Ballistic Missile Defense site in North Dakota. Figure 14 illustrates the test setup. The filter cabinet covers are constructed so that the input and output sides of the filter can be uncovered separately. The test consists of radiating the input side of the filters with RF energy (Figure 15). The first opening in the conduit system (condulet, junction box, etc.) on the opposite side of the shielding liner (output side of the filter) is opened, and the signal level at this point is measured. Antenna spacing for both the radiating and receiving antennas is 1 ft (0.3 m). Although filter tests at the SAFEGUARD facility were performed at all the frequencies used in the door tests, the WSMR test crew felt that the only significant tests were at 200 kHz and S-band. The 200-kHz test would determine if the filters and related conduit hardware were installed properly, while the S-band test would be the main determinant of the quality of the filter. CERL laboratory testing during the SAFEGUARD program supported the conclusion that tests at these two frequencies would be adequate to determine the shielding performance of the filter installation. CERL tests at the STTF included 100 MHz, mainly to determine if other unfiltered wires penetrated the shield.

All the filters except R15, R23, and R28 were tested because the wires leading to the external alarm circuitry for R15 were not connected, and the test points for R23 and R28 were relatively inaccessible. The test results are listed in Table 8, and the data sheets are presented in Appendix E. All the filters tested passed the RF attenuation tests. Although the filters performed satisfactorily in the RF tests, site personnel indicated a problem with several units having an excessive line voltage drop under load. The statement of work also requested that a representative sample of the filters be illumination tested. Therefore, the CERL test team and site personnel agreed not to test the remaining three filters due to the difficulty of conducting these tests. Since there was no unidentified leakage between zones containing these filters and all the other filters performed satisfactorily, it is reasonable to assume with a relatively high degree of confidence that the nontested filters are satisfactory.

In addition to the RFI tests, the electrical filters were inspected for conformance to the installation specification and good installation practices. No installation deficiencies were noted.

Pipe Filter Tests

The only pipe filters tested were those in the purified water supply and return pipes between rooms 110 and 111.

Table 8

Electrical Filter Test Results

Filter	Measured Attenuation, dB		
	200 kHz	100 MHz	2.5 GHz
R-1	85+	80+	80+
R-2	85+	80+	80+
R-3	100+	80+	62
R-4	103+	89+	87
R-9	76+	80+	80+
R-10	87+	80+	80+
R-11	120+	87+	93
R-12	85+	80+	80+
R-15	Not tested		
R-17	117	80	76
R-19	117	98+	81
R-20	107	98+	76
R-22	88+	70+	70+
R-23	Not tested		
R-26	85+	80+	80+
R-27	123+	78	88
R-28	Not tested		

The purified water system consists of fiberglass pipe (6-in. [152.4 mm] diameter) except where the system passes through the shielded liner between rooms 110 and 111. At this point, both the supply and return pipes have a 2 1/2 ft (0.7 m) section of stainless steel pipe (Figure 16). An RF honeycomb filter was installed in each of these pipes using conductive epoxy.

For testing, the antennas were positioned as shown in Figure 16. The transmitting horns were wired in place (Figure 17), and the receiving horns were positioned for maximum signal. The RF tests on the pipes were made at two frequencies--2.5 and 7 GHz, since the other test frequencies were well below the cutoff frequency for 6-in. (152.4 mm) round waveguide. Table 9 shows the test results, and Appendix F contains the data sheets for the tests. The RF filters were found in another part of the system after pressurization tests in which some of the field-fabricated fiberglass pipe joints failed. The conductive epoxy used to attach the filters did not hold the filters and appeared not to have hardened.

The RF filters installed in the Halon fire extinguisher system were also found downstream after a test of the extinguishing system, indicating that the conductive epoxy does not appear to be a satisfactory method for installing the filters. The Halon system, however, is

all ferrous metal pipe with a maximum internal diameter of 2 1/2 in. (63.5 mm). Little if any RF leakage through it should be possible under normal circumstances. No illumination tests were conducted, since there were no openings or nonmetallic pipe in the system to illuminate.

Table 9

Results of Water System Pipe Filter Tests

Pipe	Frequency, GHz	Attenuation, dB
PWS	2.5	10
(Purified water supply)	7	6
PWR	2.5	15
(Purified water return)	7	11

The following analysis was performed to determine when filters may be necessary for RF isolation. Round pipes act as circular waveguides with high attenuation below their cutoff frequency. The lowest frequency propagated is in the TE_{01} mode which is given by the following formula:

$$f_c = \frac{c}{\lambda_c} = \frac{4.52 \times 10^9}{r} \qquad \text{[Eq 1]}$$

f_c = cutoff frequency

λ_c = cutoff wavelength = 2.613_r

r = conduit radius in inches

c = speed of light

Table 10 shows the cutoff frequencies for various pipe diameters. Thus, it appears RF filters in conduits/pipes 2 in. (51 mm) or greater in diameter are necessary to obtain isolation up to a frequency of 7 GHz. However, where the complete system consists of totally enclosed metallic piping such as the Halon system at the STTF, it may not be possible for RF energy to enter the system, and filters may be unnecessary.

Conduit and Drain Inspection and Tests

RF illumination tests similar to those used for the electrical

Table 10

Cutoff Frequencies

Pipe or Conduit Diameter, in. (mm)	Lowest Cutoff Frequency, GHz
6 (152)	1.51
4 (102)	2.26
3 (76)	3.01
2 (51)	4.52
1 (25)	9.04

filters were conducted on selected conduits. The conduits tested were selected on the basis of their routing from one shielding zone to another and accessibility for illumination. Each test item was successively illuminated by frequencies of 200 kHz, 100 MHz, and 2.5 GHz. The receiving antenna was located at the first conduit break (e.g., pull boxes, junction boxes, or breaker boxes) beyond the shielded liner through which the conduit was routed. Appendix F presents the test results.

The electrical conduit system was inspected for conformance to the construction specification and good RF shielding practice. Particular emphasis was placed on the following items:

1. Conduit couplings were inspected to make certain that they were tight and that conductive compound was used at all joints. All the joints and couplings inspected were tight. Use of conductive compound could not be determined in every case, since the conduits had been painted.

2. Penetrations through liner plates were inspected for completeness of welds. One conduit and a 4-in. (102 mm) pipe were found not to have been welded to the liner plate. These defects were corrected while the CERL test teams were at the site.

3. Covers of boxes, enclosures, panelboards, etc., were examined to insure that they were firmly secured with no buckling and bolt spacing not to exceed 4 in. (102 mm). These items all appeared to be satisfactory. Some covers had been removed for work (conduit covers, filter cabinets), but replacement is expected after completion of work.

4. Electrical boxes were inspected for RF gaskets which were to be provided according to the construction specifications. Spot checks

of electrical boxes indicated that gaskets were in place where required. No covers were removed for inspection of gaskets, but the gaskets installed on electrical filters from which the covers were removed for testing appeared to be satisfactory.

5. The conduit system was inspected to determine specific test candidates; i.e., items for which workmanship appeared to be marginal, or items which had been exposed to higher than ordinary RF coupling because of their location. The workmanship on these items appeared to be generally of high quality, and no test candidates in which the workmanship was marginal were identified. The conduits subjected to the RF test all performed satisfactorily.

6. Special RF filter floor drains consisting of circular brass blocks with a number of drilled holes (Figure 18) were installed. These drains were welded to the floor shielding liner plate. Since testing these installations by illumination was not possible, they were visually and RF sniffer-inspected. No defects were found.

Use of improper hubs on electrical boxes was mentioned by the Resident Engineer, but this did not appear to degrade shielding effectiveness as measured by either the conduit or filter tests.

The conduit system and drain filter installations were judged to be satisfactory from an RFI shielding standpoint based on the tests and inspections.

3 ANALYSIS OF SHIELDED ENCLOSURE LEAK DETECTOR (SNIFFER) TESTS

Standard illumination test techniques for shielded enclosures (NSA-65-6, MIL STD 285, IEEE Standard 299) are difficult, if not impossible, to perform on large liner-plate shielded construction These test techniques all specify placing antennas within 12 in. (0.3 m) of either side of the shield. If the concrete is thicker than this, doing so may not be possible. It is also impractical to test all the seams of a large structure in this way due to the large number of test points and frequencies. However, since doors are generally more easily accessible, and the total length of mating surface is relatively small, thus limiting the number of test points, only door seams and items requiring a single test point (pipe filters, electrical filters, etc.) at the SSTF were tested using the illumination technique (NSA 65-6).

Shielded enclosure leak detection system (sniffer) tests are an industry-accepted, but apparently not well-documented, technique for evaluating the performance of a shielded structure. In some cases, only sniffer tests are conducted. In these tests, an RF current is induced on the structure by direct connection, while in illumination tests the RF currents are induced by a radiated field. The sniffer uses a single frequency (approximately 100 kHz) with an audio tone modulation, while the illumination tests can be done at any frequency. The entire structure is excited at once for the sniffer tests and examination of the shielded room or zone can be accomplished quite rapidly compared to the time required for the multi-frequency illumination technique. Unfortunately, due to the limited documentation and analysis, it is not possible to make a definite statement about the correlation between the single-frequency sniffer tests and the illumination tests at different frequencies. The sniffer seems to be a good indicator of seam quality, which is quite often the limiting factor in a shielded structure.

Sniffer tests of large complex shielded structures do have a number of disadvantages:

1. The room or shielded zone must be complete with doors, with access panels in place and closed for the testing. Thus, this test cannot be conducted in the early construction phases of the liner plate structures. An additional problem which resulted in incomplete testing of the STTF was the installation of perforated metallic sound proofing walls and tile floor covering prior to sniffer testing of the seams. Thus visual location of the covered seams was impossible. The covered areas were scanned and a crack was found beneath the floor tile. Here it was necessary to remove the tile in the area before the rewelding could take place. No leaks were found on the walls covered with the sound proofing material. Unfortunately, delaying

other aspects of construction until a shielded zone is completed for sniffer testing can significantly delay completion of construction.

2. Interior walls between shielded zones are probably not excited by the standard connections used for the sniffer signal source. This effect can be seen from the two-dimensional drawing of a multi-zone shield (Figure 19). The RF current (approximately 100 kHz) will tend to flow on the outside of the structure, and the wall between the two zones will not carry very much of this current. This wall could be excited from inside the second zone, as proposed in Figure 19 (points O - O). Sniffer tests would then be conducted in zone 1. The excitation should be from diagonally opposite corners and should be alternated as was done for the exterior connections.

3. Sniffer test operators should be aware that both a meter indication and audio tone are necessary to identify a leak. The sniffer will pick up any internally generated signal in its passband, thus possibly giving a meter indication where no leak exists. Therefore both the audio signal and meter reading are necessary for positive identification of leaks since there is very little probability that an internally generated signal and the sniffer excitation signal will be modulated by the same frequency.

4. A defect can be oriented such that it may not be detected for a particular connection of the signal source, e.g., when the major axis of the defect is parallel to the current flow between the connection points on the structure. Thus, using two sets of diagonally opposite corners of the structure as excitation points and sniffing each seam twice is necessary. It is possible that satisfactory results could be obtained if the excitation signal were switched (or multiplexed) between the two sets of corners at a rate of 5 to 10 times per second. The multiplexing rate should be rapid in relationship to the rate of sniffer probe movement.

5. The signal detected by the sniffer probe depends on defect location with respect to the excitation points. Current densities are considerably greater near these points than on the opposite sides or edges of the structure. Thus, a defect near one of these points may give a larger reading than an equivalent defect at a point where the current density is less. This fact, coupled with the defect orientation characteristics discussed above, are among the reasons that sniffer measurements are difficult to correlate with illumination measurements. Another complicating factor is the frequency-dependent reflection responsible for part of the shielding for illumination measurements. This cannot be measured by the sniffer.

4 CONCLUSIONS AND RECOMMENDATIONS

STTF Shielding Effectiveness

The results of the tests and inspections in relation to contract shielding specifications are as follows:

1. Liner plate--satisfactory after rewelding of defects.

2. Electrical filters--satisfactory.

3. Air duct filters--satisfactory.

4. Conduit system--satisfactory.

5. Drains--satisfactory.

6. Doors--satisfactory with the exception of doors 109 (exterior) and 201 (exterior).

7. Pipe filters--unsatisfactory.

Except for the items mentioned in 6 and 7 above, the STTF shielding subsystem meets the specifications.

Sniffer Tests

The sniffer test provides a useful technique for determining the shielding integrity of a structure. This test is much easier to conduct than illumination testing of large liner-plate shielded construction. Therefore, to facilitate testing of future shielded construction similar to the STTF, the following actions are recommended:

1. Sniffer connection boxes should be provided as they were for the STTF.

2. Additional test connections should be provided for interior shielded wall testing.

3. When feasible, construction should be scheduled to allow for sniffer testing of all seams.

Additional laboratory study should be made to:

1. Determine the feasibility of multiplexing the sniffer signal to allow inspection of seams in one pass.

2. Determine the feasibility of substituting the sniffer test for the illumination test of doors, considerably reducing testing and equipment required, and/or using the sniffer for door maintenance purposes.

3. Develop sniffer techniques which could be used before construction is complete.

4. Determine correlation between RF attenuation tests, specification requirements, and sniffer test results.

5. Determine effects of covering the shield liner with metallic and nonmetallic construction materials.

Doors

Two of the doors did not meet the required attenuation specifications at 1 kHz.* Since other doors of the same design and other points on these doors met the attenuation requirement at this frequency, this failure does not appear to be due to a design weakness. It is probably caused by oxidation or corrosion in the doorframe channel which houses the fingerstock. It is therefore recommended that this frame be thoroughly cleaned, coated with RF conductive grease, and the gold-plated fingerstock replaced. At the same time, the door knife edge should also be cleaned and covered with the conductive grease. It is recommended that this treatment be applied to all exterior doors. Since there are no emissions at 1 kHz at the facility, it is suggested that the rather stringent 40-dB shielding requirement may be reduced with no detriment to the operation of the STTF. However, the treatment with the RF conductive grease should still be carried out.

Periodic maintenance will be required on doors subjected to significant use. The minimum should be a monthly inspection, cleaning of fingerstock, replacement of broken fingerstock, and cleaning of mating door and doorframe parts, as recommended for the SAFEGUARD facility. Actual shielding performance can only be verified by retesting. It was determined that illumination testing at 200 kHz and S-band (2.5 GHz) gave an adequate measure of shielding performance for testing SAFEGUARD facilities, since doors meeting the shielding

* Door 109 (exterior) had one test point with 73 dB attenuation at 7 GHz before the fingerstock was cleaned. The door has a 75-dB requirement and was not retested at 7 GHz after cleaning since no improvement was obtained at 1 kHz. Judging from the CERL tests at the SAFEGUARD facility, cleaning the fingerstock can be expected to improve the measured shielding effectiveness considerably more than 2 dB at this frequency. This minor deviation should have no effect on system operation.

requirements at those frequencies also met the requirements at other frequencies. If periodic retesting is conducted, it is recommended that test frequencies of 200 kHz and 2.5 GHz only be used, with the possible addition of 1 kHz to verify the low frequency shielding. Unless inspection results indicate that a more frequent retest is necessary, retesting every 6 months should be adequate.

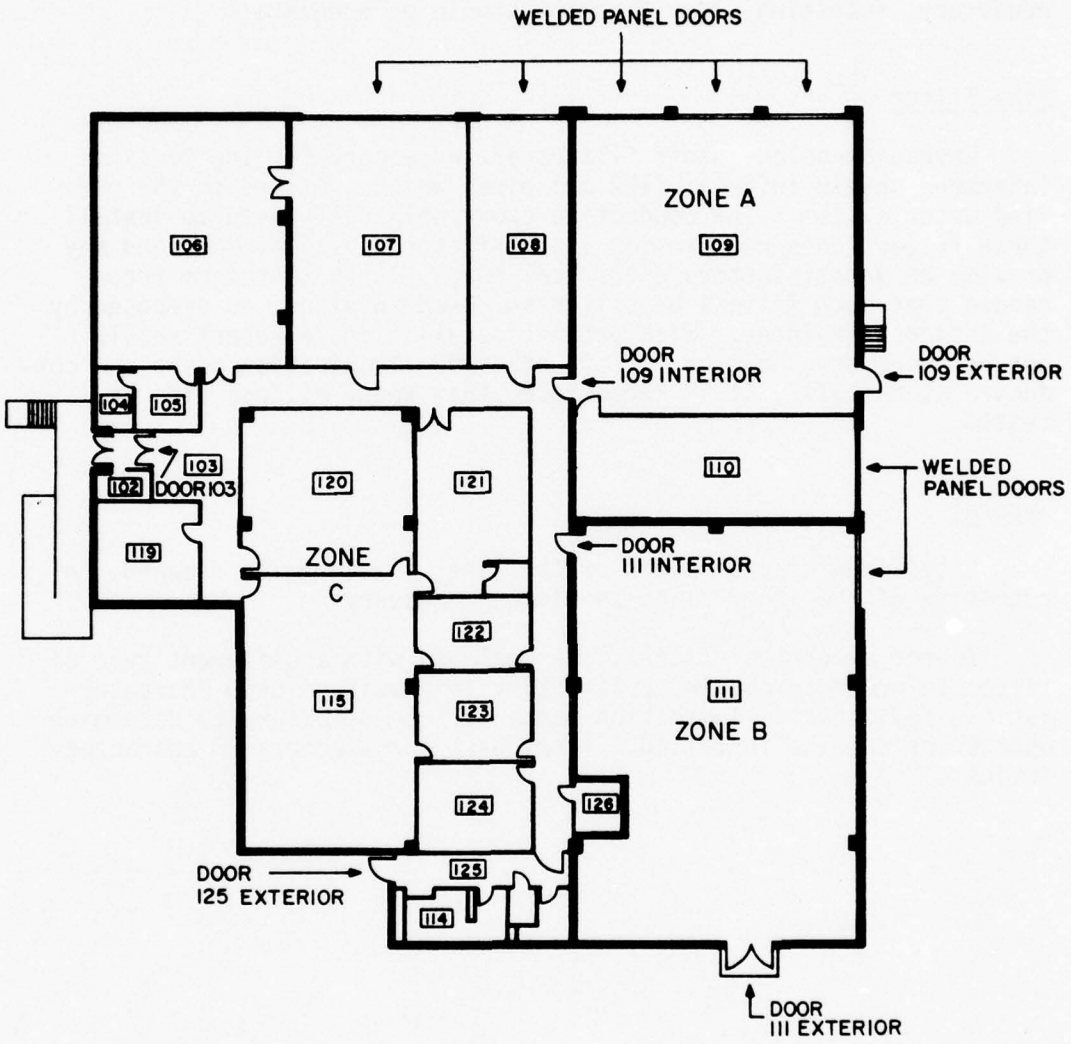
Pipe Filter

Waveguide-below-cutoff filters are necessary for the required interzone shield in 6-in. (152 mm) pipes which are used in the purified water system. The conductive epoxy originally used to install these filters does not provide a satisfactory physical bond and may provide an unsatisfactory electrical bond. It is therefore recommended that such filters be silver-soldered in place, as proposed by the Resident Engineer. With proper installation, a retest should not be necessary; however, if any other RF illumination tests are conducted at the STTF, it is recommended that these filters also be tested.

General

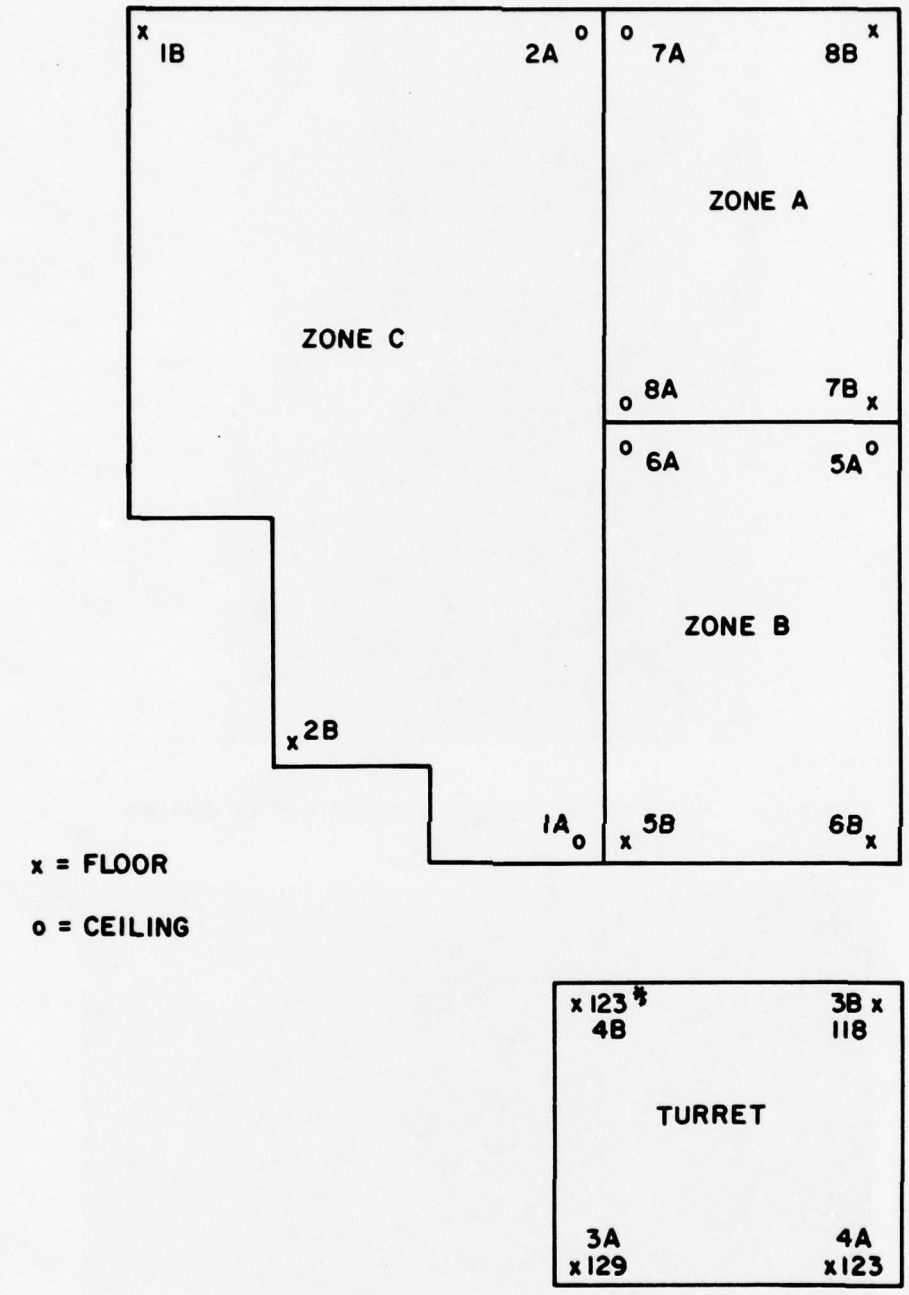
Unless new cracks appear or the liner is otherwise damaged, no retesting of the liner plate should be necessary.

If the electrical filters are replaced with a different type of filter in order to obtain satisfactory line voltage drop characteristics, additional illumination tests will be necessary to determine whether or not the installed filters have satisfactory RF characteristics.



Note: Door 201 is located on turret, which is Zone A.

Figure 1. Floor plan. Dark lines are shielding zone boundaries; zone D is outside the building.



*These numbers denote elevations.

Figure 2. Shielded enclosure leak detection system excitation points.

Figure 3. Shielded enclosure leak detection system ("sniffer") in use.

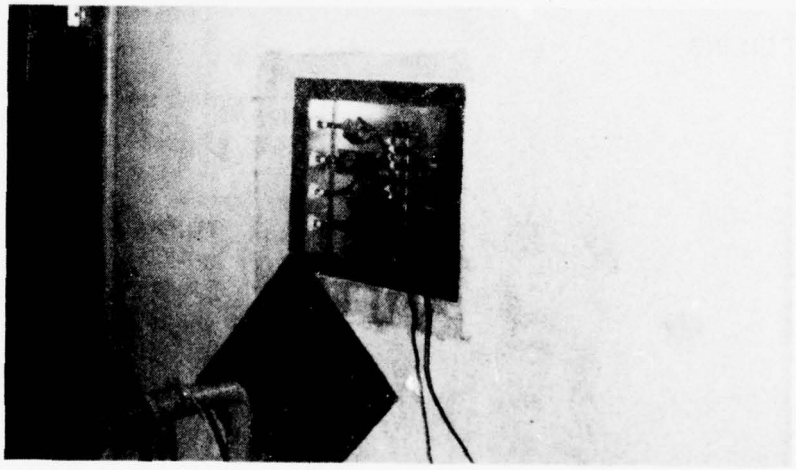


Figure 4. Connection box for shielded enclosure leak detection system.

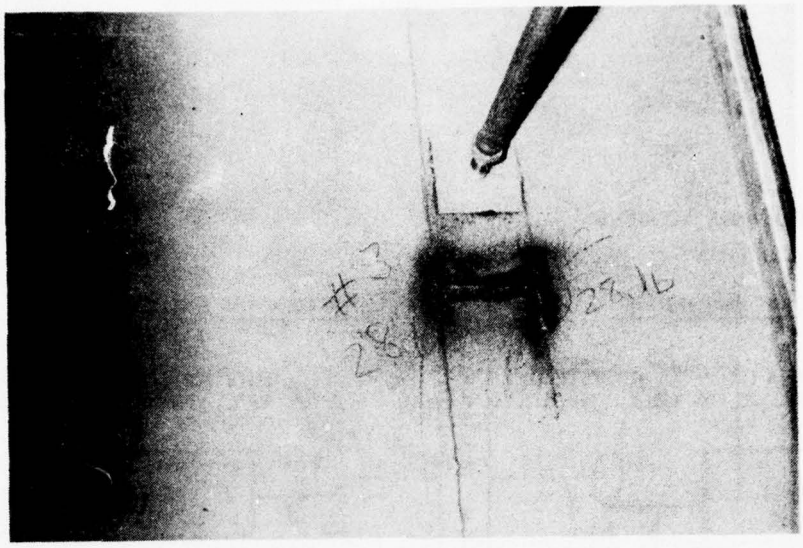


Figure 5. Repaired leaks on floor, room 115.

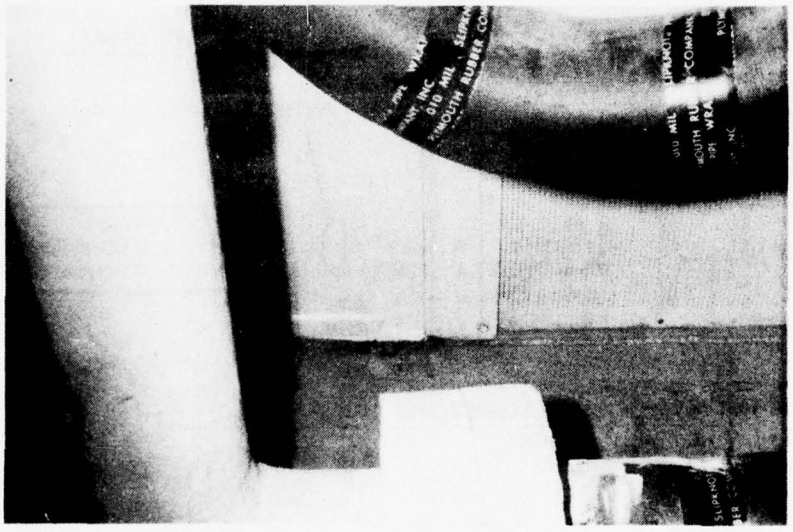


Figure 6. Repaired leak on panel door, room 110.

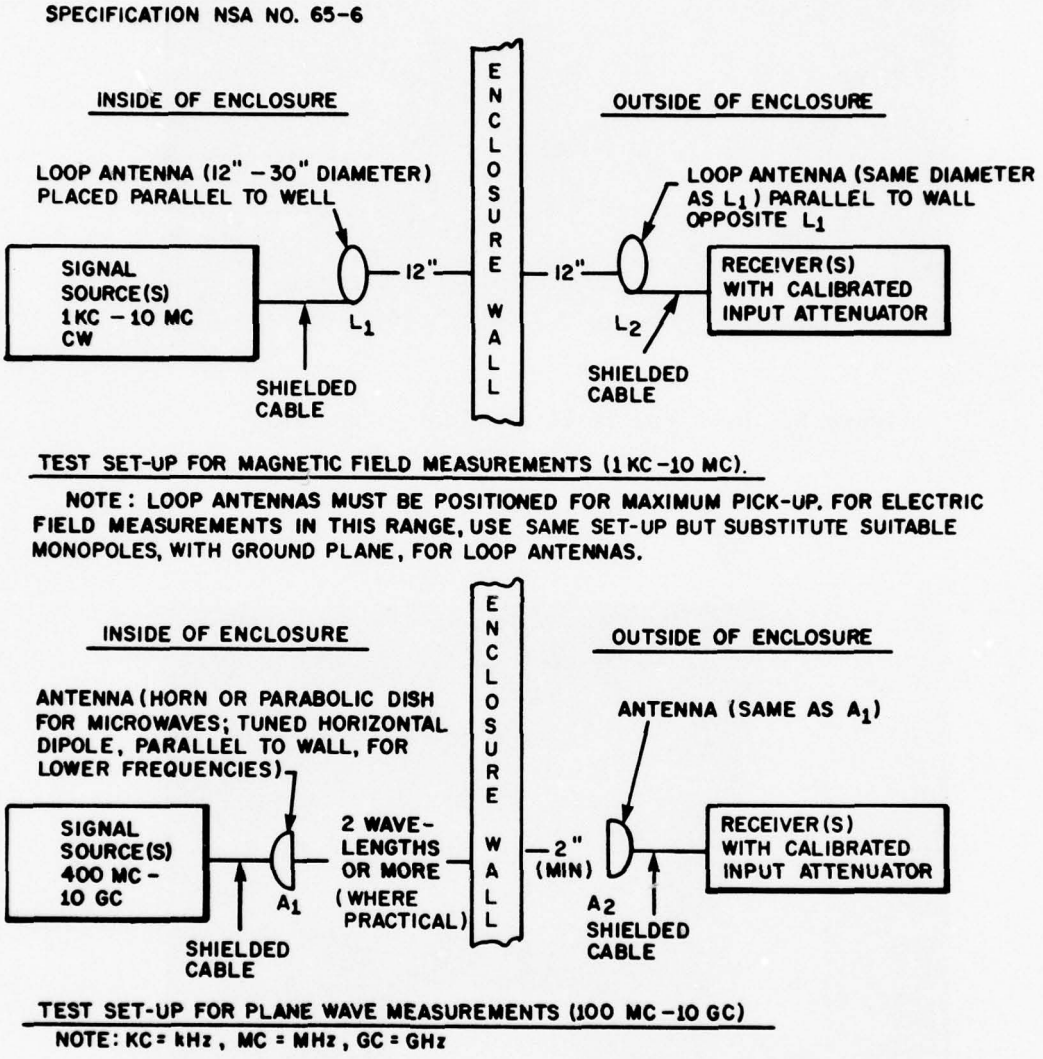


Figure 7. RF attenuation measurements test configuration. From NSA Specification 65-6.

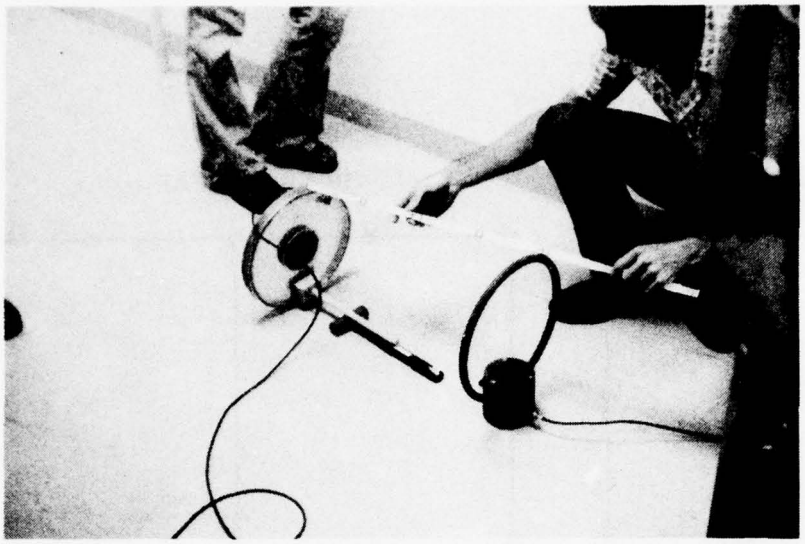


Figure 8. Positioning antennas for reference reading (200 kHz to 10 MHz).

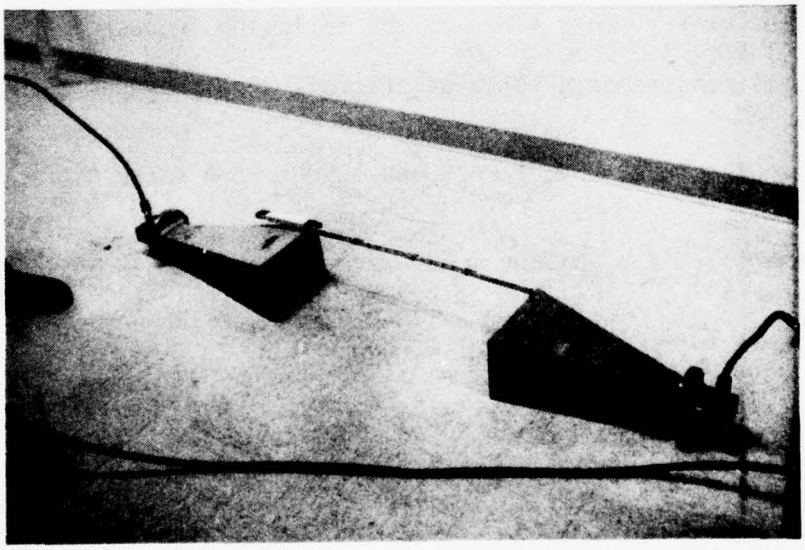
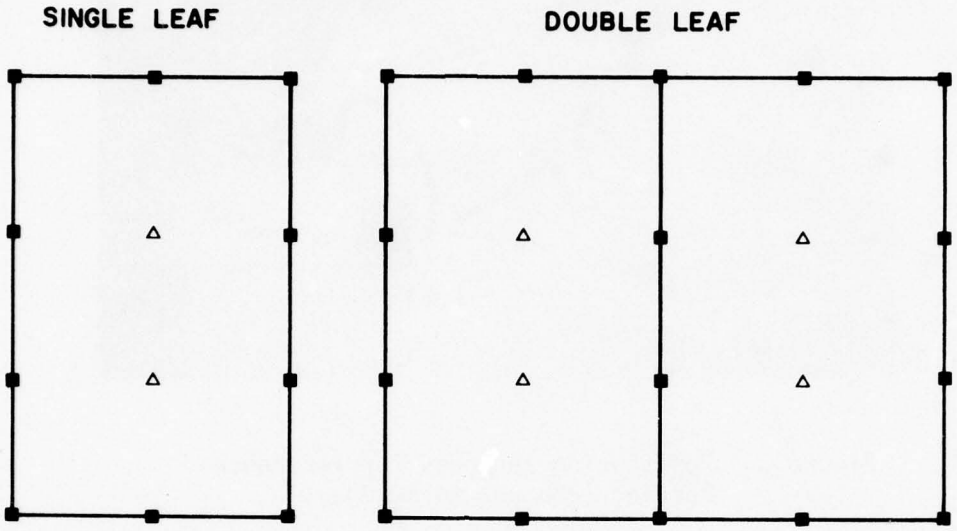


Figure 9. Antenna position for reference reading (2.5 GHz).



■ Designates measurements taken at the following frequencies: 60 Hz, 400 Hz, 1 kHz, 4.5 kHz, 10 kHz.

Δ Designates measurements taken at the following frequencies: 100 MHz and 500 MHz.

Measurements at 200 kHz, 1 MHz, and 10 MHz were taken every 24 in. (0.6 m).

Measurements at 2.5 GHz and 7 GHz were taken every 12 in. (0.3 m).

Figure 10. Door test points.

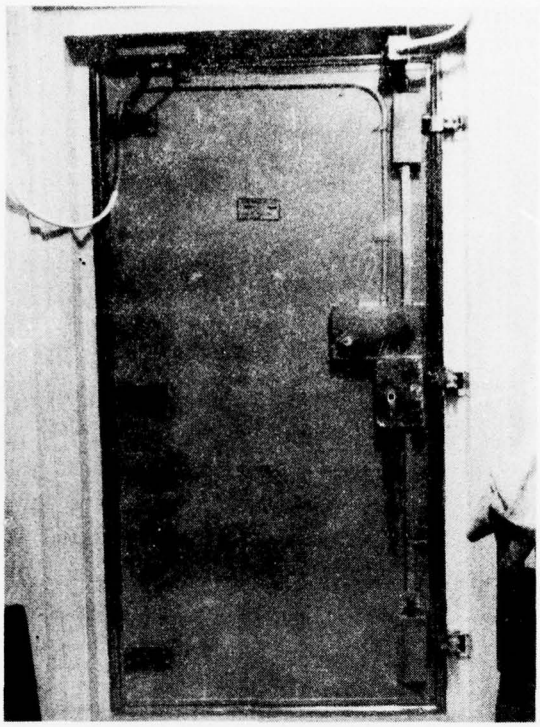


Figure 11. RF shielded door (201, exterior) with test points marked.

Figure 12. Radiating antenna (60 Hz to 10 kHz) positioned for test.

Figure 13. Damaged fingerstock, RF shielded door 111 (interior).

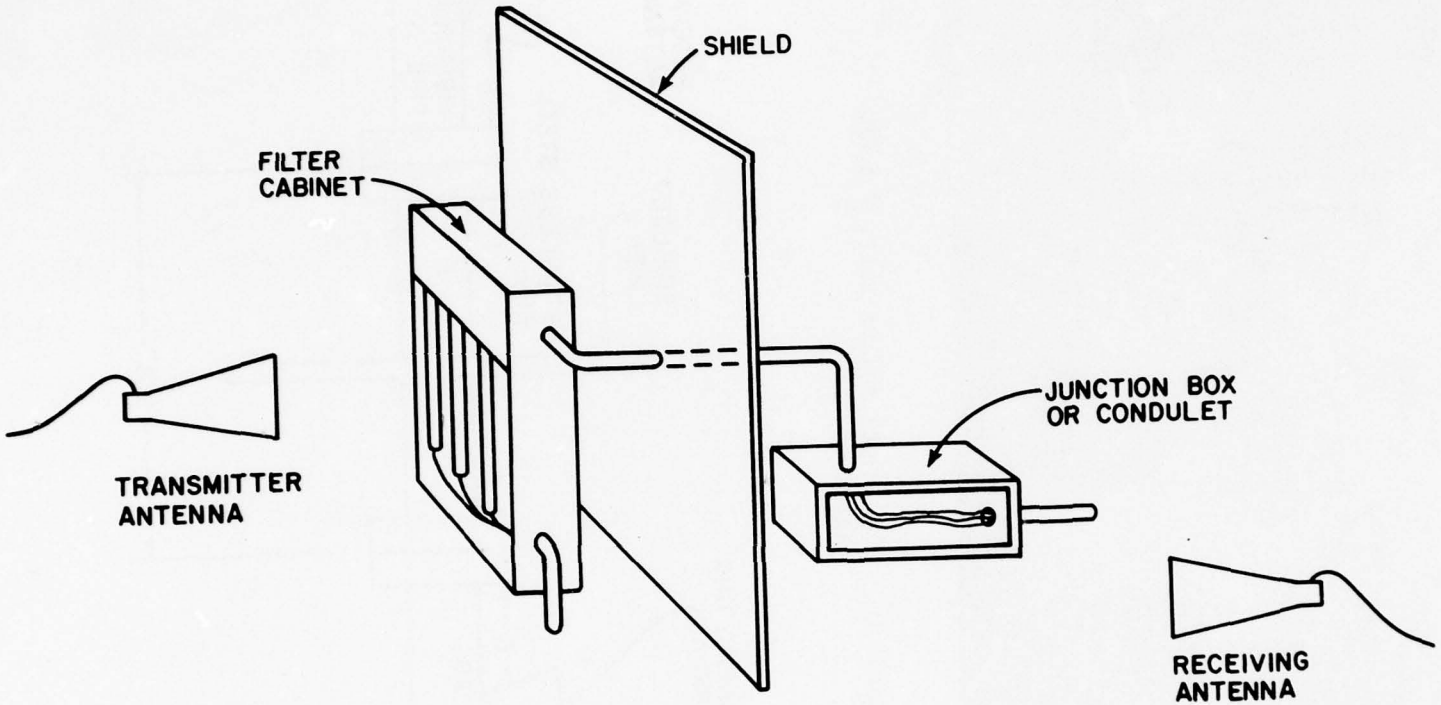


Figure 14. Electrical filter illumination test.

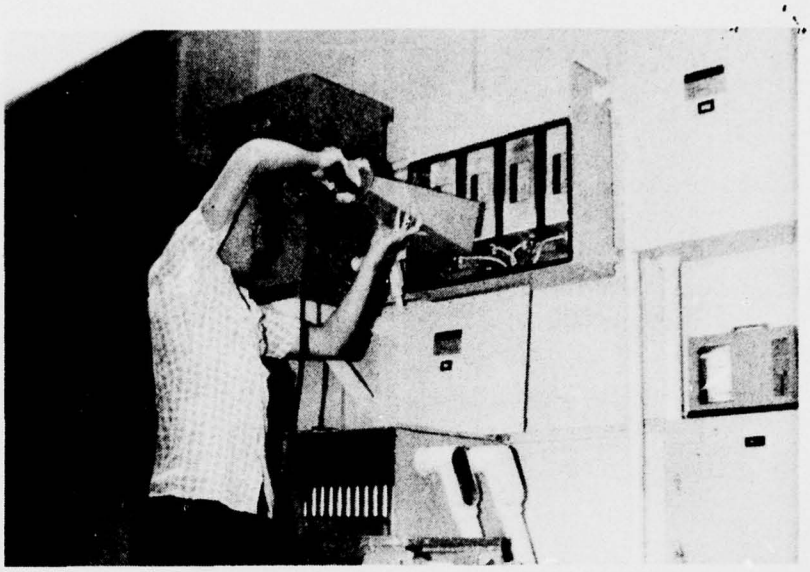


Figure 15. Electrical filter test, 2.5 GHz radiation.

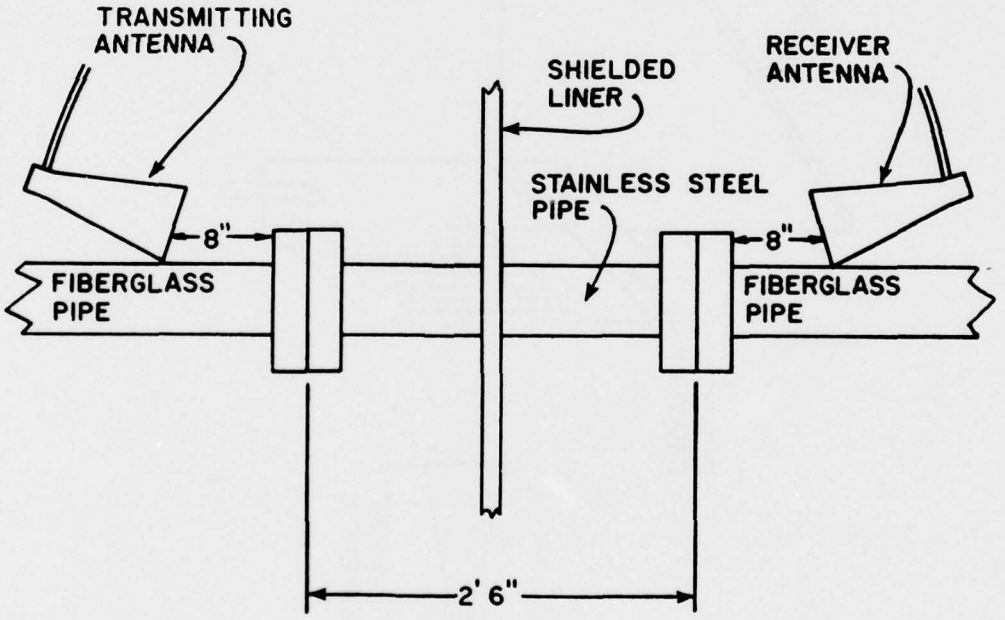
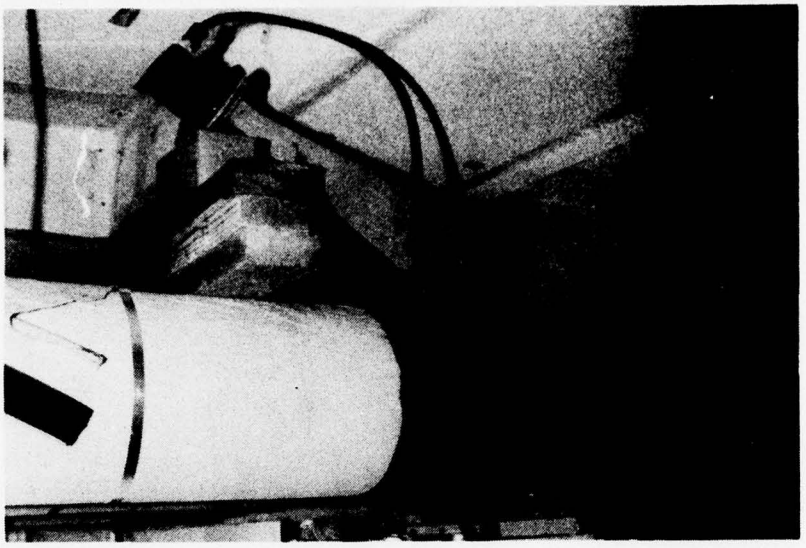
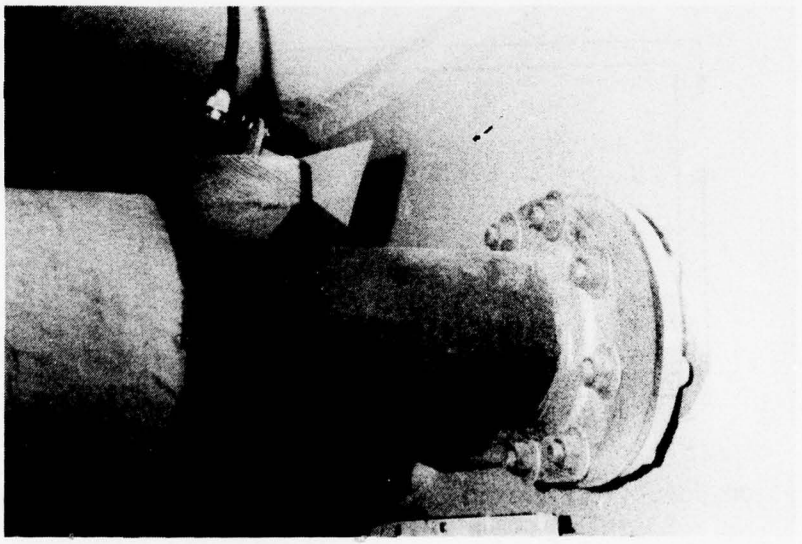


Figure 16. Pipe filter test setup.



a. 2.5 GHz



b. 7 GHz

Figure 17. Pipe filter illumination test.

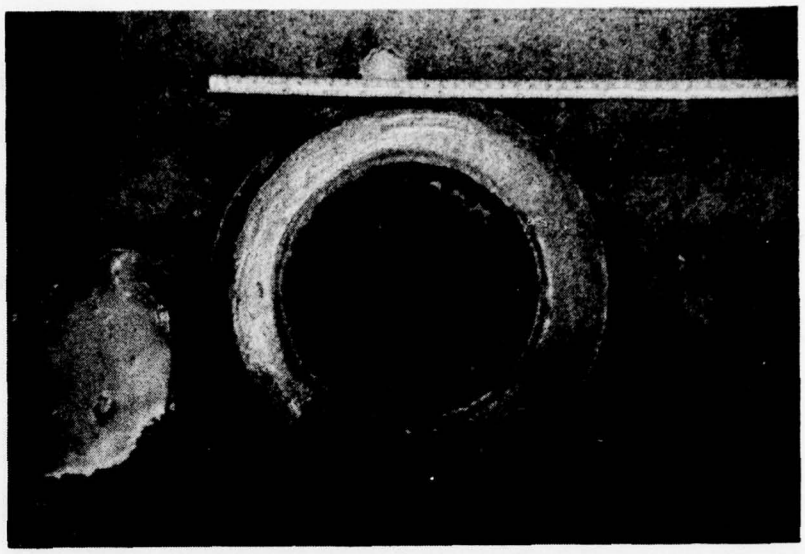
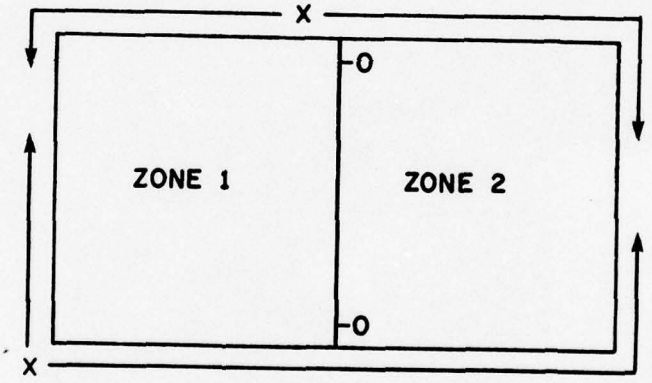


Figure 18. Brass floor drain filter welded in place.



x = Excitation points for zone 1. Arrows indicate current flow.

0 = Proposed test connections for inter-zone wall.

Figure 19. Sniffer excitation of a two-zone shielded structure.

APPENDIX A:

TEST PLAN FOR RFI TESTING OF SYSTEM
TECHNOLOGY TEST FACILITY (STTF)

1.0 Background. This plan outlines inspection and test procedures proposed by CERL for RFI (Radio Frequency Interference) shielding of the System Technology Test Facility (STTF) on Meck Island, Kwajalein Atoll, Marshall Islands, as requested by the Statement of Work (draft) dated 10 June 1976.

1.1 Purpose. The purpose of these tests is to verify the shielding integrity of the STTF. This test plan will also, along with the statement of work, serve as a guide to the test crew for conducting the tests.

2.0 Statement of Services. CERL will provide equipment and labor to perform the following services:

a. Sniffer tests of liner plate

b. RFI attenuation tests of seven doors

c. RFI filter inspection and tests, as specified:

(1) air duct filters

(2) pipe filters

(3) electrical filters

d. Inspection and possible test of RFI-tight conduit system

e. Anomalies are to be reported to Resident Engineer and reinspected and retested after repair.

2.1 Liner Plate Tests. These tests will be conducted by sniffer with a 100 kHz signal and by scanning the inside with a tuned receiver. According to the scope of work, embedded RFI test circuits are attached externally to the diagonally opposite corners of the shielded zone. The test will consist of scanning all the welds of the shielded zone with the tuned receiver. This must be done twice for each zone, since not all defects may be located with one excitation mode of the structure. Thus, the embedded test circuits are attached to two sets of diagonally opposite corners of the shielded zone.

These tests need to be conducted after the shielded zone is complete and before wall, floor, or ceiling coverings are placed. Doors must also be closed and provide good attenuation so that a low background level exists for the measurements.

Faulty welds are to be reworked by the construction contractor and the sniffer test repeated for the repaired seam.

Test results will be logged on Type 1 data sheets.

Moveable scaffolding will be necessary to conduct sniffer tests of wall and ceiling seams.

Equipment furnished by CERL for this test will be the sniffer and its associated signal source.

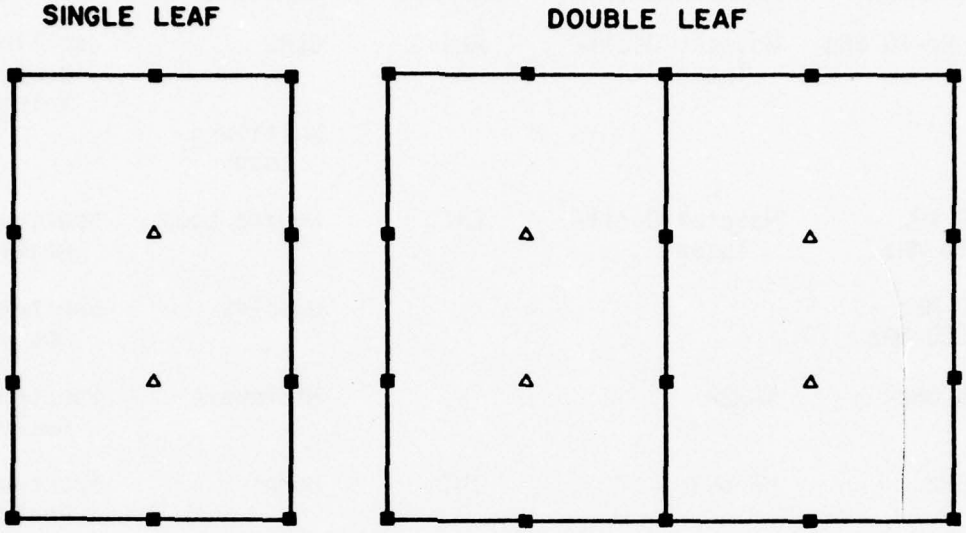
2.2 RFI Testing of Shielded Doors. The RF attenuation testing of installed door assemblies will be conducted according to the techniques outlined in Figure 2 of Specification NSA No. 65-6. The attenuation requirements are as follows:

Door Assembly	Attenuation	Frequency
All RFI doors	6 dB	60 Hz
All RFI doors	20 dB	400 Hz
All RFI doors	40 dB	1 kHz to 10 kHz
103, Interior	67 dB	10 kHz to 7 GHz
109, Interior	59 dB	10 kHz to 7 GHz
109A, Exterior	75 dB	10 kHz to 7 GHz
111, Interior	48 dB	10 kHz to 7 GHz
111A, Exterior	48 dB	10 kHz to 7 GHz
125, Exterior	67 dB	10 kHz to 7 GHz
201, Exterior	78 dB	10 kHz to 7 GHz

The test procedure will be to illuminate the door at a sufficient number of points around its periphery to determine the attenuation performance of the door. Based on the FACT testing at the Stanley Mickelson Safeguard BMD site and the requirements for these doors, test frequencies and spacing of test locations shown on the following page are proposed.

Contractor services required for these tests include: preparation of the doors for tests, scaffolding, lighting, and qualified welder or servicemen to service or repair doors which do not meet the attenuation requirements. In order to expedite testing, it will be necessary for the individual to accompany the CERL test personnel at the time of testing. He can then do minor repairs or cleaning which may be necessary for the tests to be completed. Major defects will probably require more extensive rework and retesting at a later time.

DOOR TEST POINTS



■ Designates measurements taken at the following frequencies: 60 Hz, 400 Hz, 1 kHz, 4.5 kHz, 10 kHz.

Δ Designates measurements taken at the following frequencies: 100 MHz and 500 MHz.

Measurements at 200 kHz, 1 MHz, and 10 MHz were taken every 24 in. (0.6 m).

Measurements at 2.5 GHz and 7 GHz were taken every 12 in. (0.3 m).

The door test results will be logged on a type 2 data sheet.

The following equipment will be furnished by CERL to conduct these tests.

Frequency	Signal Sources	Amplifier	Antennas	Receiver
60 Hz-10 kHz	Wavetek Oscillator	Audio	CERL Multiturn Loop	Oscilloscope or Voltmeter
200 kHz - 10 MHz	Wavetek Oscillator	ENI	Empire Loop	Spectrum Analyzer
100 MHz - 500 MHz			Dipoles	Spectrum Analyzer
2.5 GHz	NARDA	--	Microwave	Spectrum Analyzer
7 GHz	HP 693	TWT	Horns	Spectrum Analyzer

Backup receiver: NM12AT
NF105

The FACT testing at the SAFEGUARD site showed that defects unrelated to the door can often be discovered during door testing. Such defects must then be repaired before the door can be tested.

2.3 R Filter Inspection and Test. All air duct filters and electrical filters will be visually inspected for compliance with Sections 15E and 16F of the contract specifications. The piping/shielding interface wherein pipe filters are installed shall be inspected. Candidates for tests will be selected on the basis of the evidence of possible defects, ready accessibility, and location on a zone interface.

The proposed tests are RFI illumination and are similar for all three types of filters. However, the tests will have to be modified for each application and will be described separately.

a. Air Duct Filter Tests. The RFI attenuation requirements for the air duct filters are as follows:

Location	Frequency	Attenuation
All filters	60 Hz	6 dB
All filters	400 Hz	20 dB
All filters	1 kHz to 10 kHz	40 dB
Exterior Walls - Rooms 109 & 110	10 kHz to 7 GHz	75 dB
Exterior Wall or Roof - Room 111	10 kHz to 7 GHz	31 dB
Exterior Wall or Roof - Other Rooms	10 kHz to 7 GHz	67 dB
Interior Wall - Room 109 & 110 to Room 108 or 125-C	10 kHz to 7 GHz	59 dB
Interior Wall - Room 111 to Rooms 110, 112 or 125-C	10 kHz to 7 GHz	48 dB

The test technique is the same as that used for SAFEGUARD air duct filters. This consists of illuminating one side of the filter and measuring the signal received on the other side. Unfortunately, if testing is done when the ducts are completed, the test frequencies will be limited by the size of the antennas the attached duct can accommodate.

The inspection and test results will be logged on a type 3 data sheet.

The equipment used for air duct filter tests is the same as that listed for the door tests.

b. Pipe Filter Tests. Water, sewage, gas, and other lines are plastic except where they are routed through the liner plate. At this point they enter through metal ducted sections which contain a honeycomb type of filter. The test proposed for this type of filter is to illuminate the ducted section where it passes through the liner. Ideally this would be done with the plastic pipe removed to allow for direct illumination of the honeycomb. However, a meaningful test can also be made with the plastic pipe in place and the antennas placed in the nearest possible approximation to direct illumination.

The frequencies proposed for testing of the pipe filters are the same as those for the doors. The test results will be logged on a type 3 data sheet.

c. Electrical Filter Tests. The RFI tests proposed for electrical filters are similar to those used for the FACT testing at the SAFEGUARD site. This consisted of illuminating the modified filter box with RF energy and measuring the transmitted signal at the first condulet, junction box, or similar break in the conduit inside the shielded zone. The filter box was modified by cutting the lid so that the part

covering the "dirty" side of the filters could be removed for the illumination. The part of the cover over the filter remains in place for the test. Factors influencing the choice of filters to be tested are: accessibility, installations subject to question (as determined by visual inspection), and attachment and penetration of zone interfaces.

Equipment to be used for this test is the same as that proposed for door testing. The data will be logged on a Type 4 data sheet.

The planning estimate for the number of these test plans is six.

The proposed test frequencies are: 200 kHz, 100 MHz and 3 GHz.

2.4 RFI-Tight Conduit System Inspection and Test. The RFI-tight conduit system will be identified and inspected for compliance to Section 16A of the contract specifications and good RFI design practice. The inspection will include the following:

a. Conduit couplings tight with conductive compound at all joints

b. Penetrations for liner place circumferentially welded

c. Covers of boxes, enclosures, panelboards, etc., firmly secured with no buckling and with bolt spacing not to exceed 4 in.

d. RFI gaskets provided according to specifications

e. Determination of test candidates which are items for which workmanship appear marginal or may be exposed to higher than ordinary RF coupling because of their location.

The proposed test is similar to the electrical filter test. The item would be illuminated at the test location. The receiving antenna would be located at the first conduit break, such as a pull box, junction box, breaker, etc., beyond the first shielded liner through which the conduit passes. The test frequencies proposed for the test are: 200 kHz, 100 MHz and 3 GHz.

The data will be logged on a Type 4 data sheet.

3. Schedule. The expected start date for this testing is about 16 August 1976 for Zones B and C and 4 October for Zone A; the duration of each increment of tests is expected to be 42 calendar days. The testing will be scheduled on off-duty hours, as much as possible, to reduce interference between CERL and the construction contractor.

Scheduling of individual tests is not possible now, since the time the tests can be conducted will be dependent upon progress by the

construction contractor. Sniffer tests of the liner will probably be conducted first, in order to allow the construction contractor to proceed with interior finishing. However, doors, filters, etc., must be in place and operating satisfactorily for the sniffer tests to work.

4. Reporting. Test results will be reported by monthly letter reports. These reports are scheduled to be submitted to the contracting officer by the 10th of the month following the reported activities. A preliminary draft of the test report covering all of the testing is scheduled for submission to the contracting officer within 30 days after completion of tests. Submission of the final version is scheduled for 60 days after completion of tests. All tests and inspections will be documented. As requested in the scope of work, the report will include the following:

a. Schedule

b. Description of each test, including test setup

c. Equipment employed

d. Anomalies

e. Participants

f. Test data and log sheets

g. Compilation and analysis of results to indicate zone attenuation

h. Recommendations for design or test changes for future application

i. Complete details on the results of sniffer tests

j. Any other applicable information.

Distribution for the preliminary draft and final test reports is:

6 copies - USAED
Pacific Ocean Division

3 copies - USAED
Huntsville Division
HNDED-M

5. Support Requirements. Contractor support requirements for each test are listed with the test description. They include scaffolding where required, and possible modification of filter box covers. Other necessary support includes:

a. Typing for monthly reports and other correspondence

b. A secure location for test equipment

c. An administrative aid for shipment of equipment, if necessary, to CERL after completion of tests.

APPENDIX B:

SHIELDED ENCLOSURE LEAK DETECTION
SYSTEM (SNIFFER) TEST RESULTS

This appendix presents the data sheets for the sniffer tests. Data sheets are presented by room, in the following order:

DATA SHEET

Sniffer Test of Liner Seams

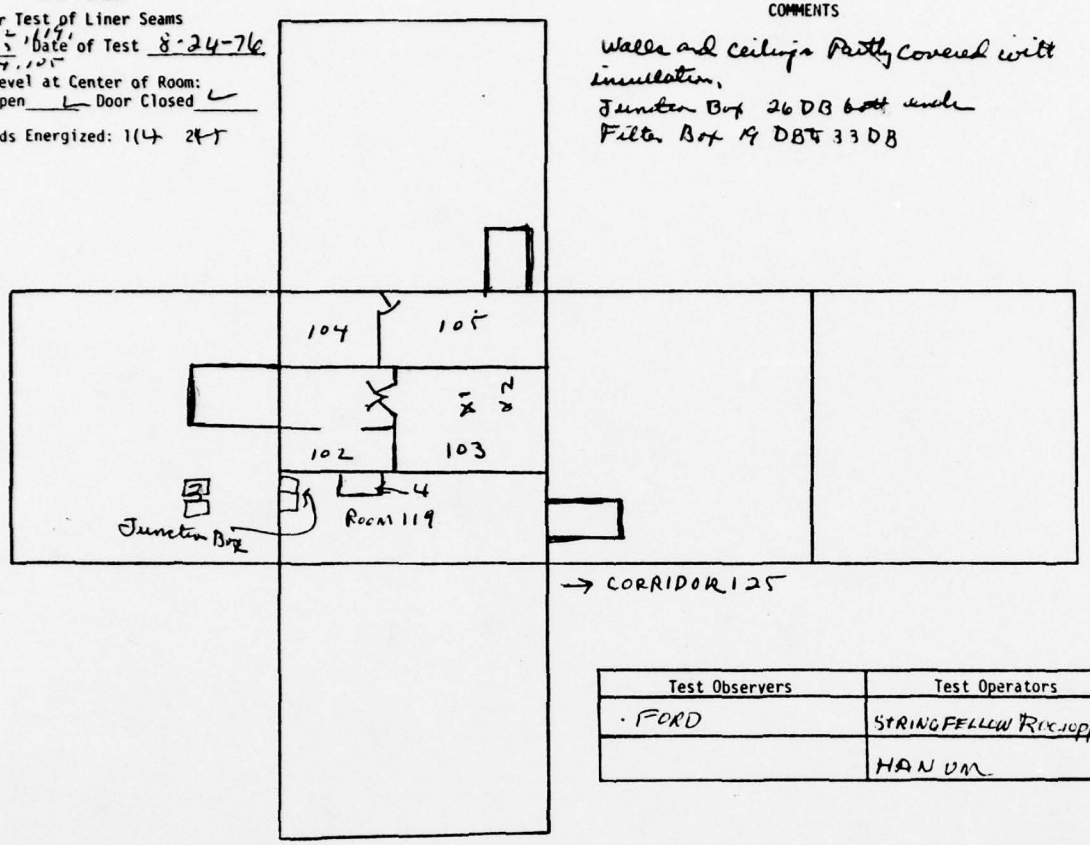
Room #'s 104, 119, 117, 105 Date of Test 8-24-76

Signal Level at Center of Room:
Door Open L Door Closed L

Test Leads Energized: 1(4 2+

COMMENTS

Walls and ceiling Partly covered with insulation.
Junction Box 26 DB ~~bott~~ under
Filter Box 4 DB+ 33 DB



Location	Level
1	30DB
2	19DB
3	25DB
4	19-33DB

Test Observers	Test Operators
· FORD	STRINGFELLOW Rickopp1
	HANUM

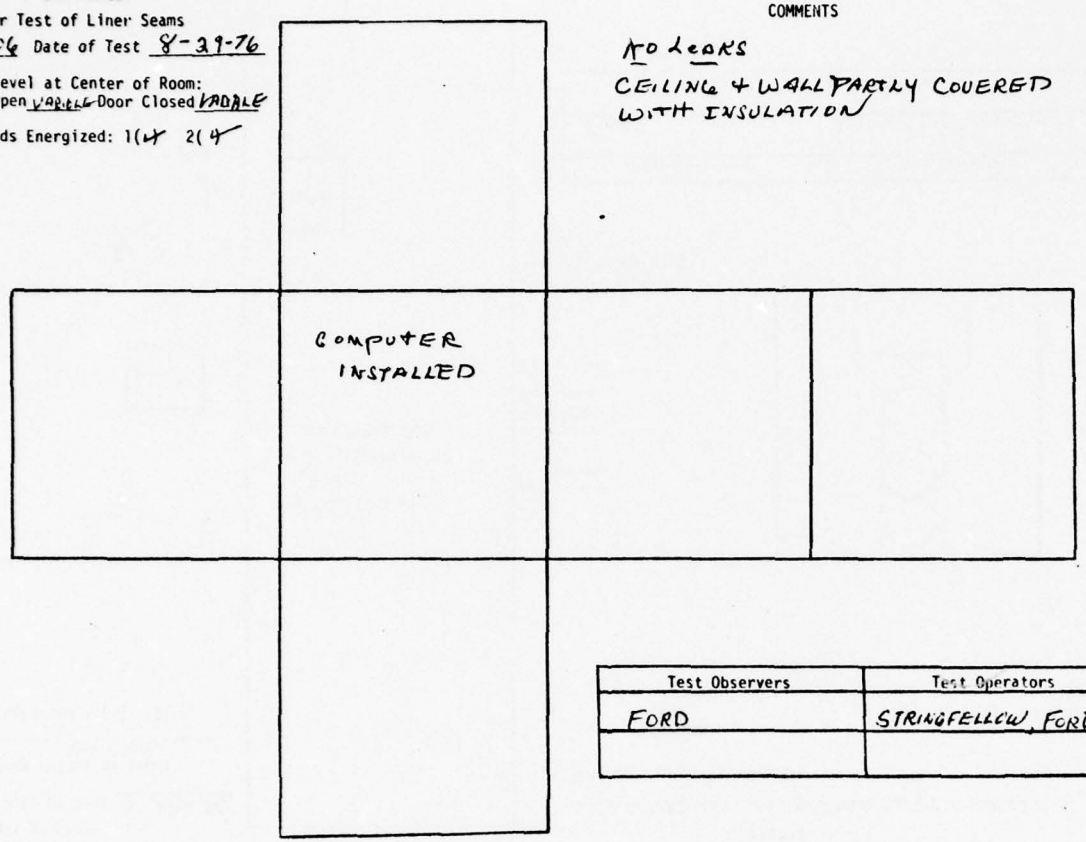
DATA SHEET

Sniffer Test of Liner Seams

Room #106 Date of Test 8-29-76

Signal Level at Center of Room:
Door Open VARIABLE Door Closed VARIABLE

Test Leads Energized: 1(4 2(4



COMMENTS

NO LEAKS

CEILING & WALL PARTLY COVERED WITH INSULATION

Test Observers	Test Operators
FORD	STRINGFELLOW, FORD

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

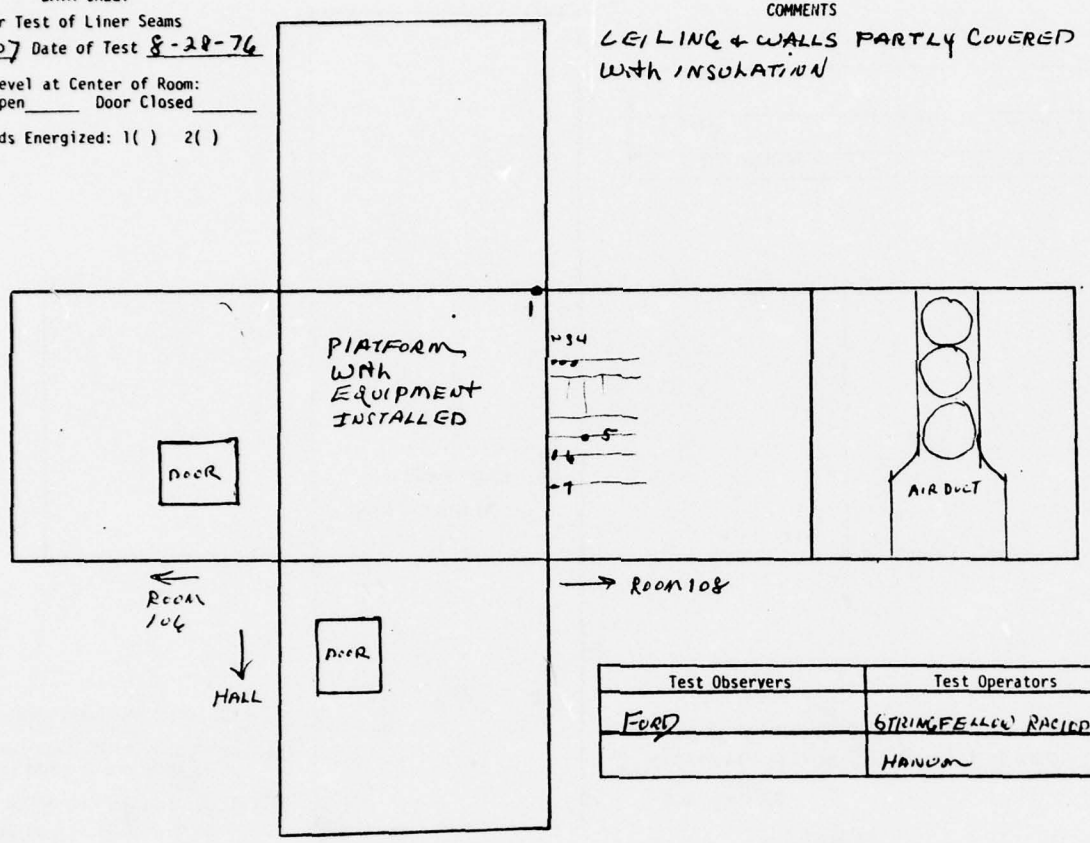
Room #107 Date of Test 8-28-76

Signal Level at Center of Room:
Door Open_____ Door Closed_____

Test Leads Energized: 1( ) 2( )

COMMENTS

CEILING & WALLS PARTLY COVERED WITH INSULATION



Location	Level
1	20 DB
2	39 DB
3	34 DB
4	31 DB
5	18 DB
6	14 DB
7	17 DB

Test Observers	Test Operators
FORD	STRINGFELLOW RACIOPPI
	HANUM

DATA SHEET

Sniffer Test of Liner Seams

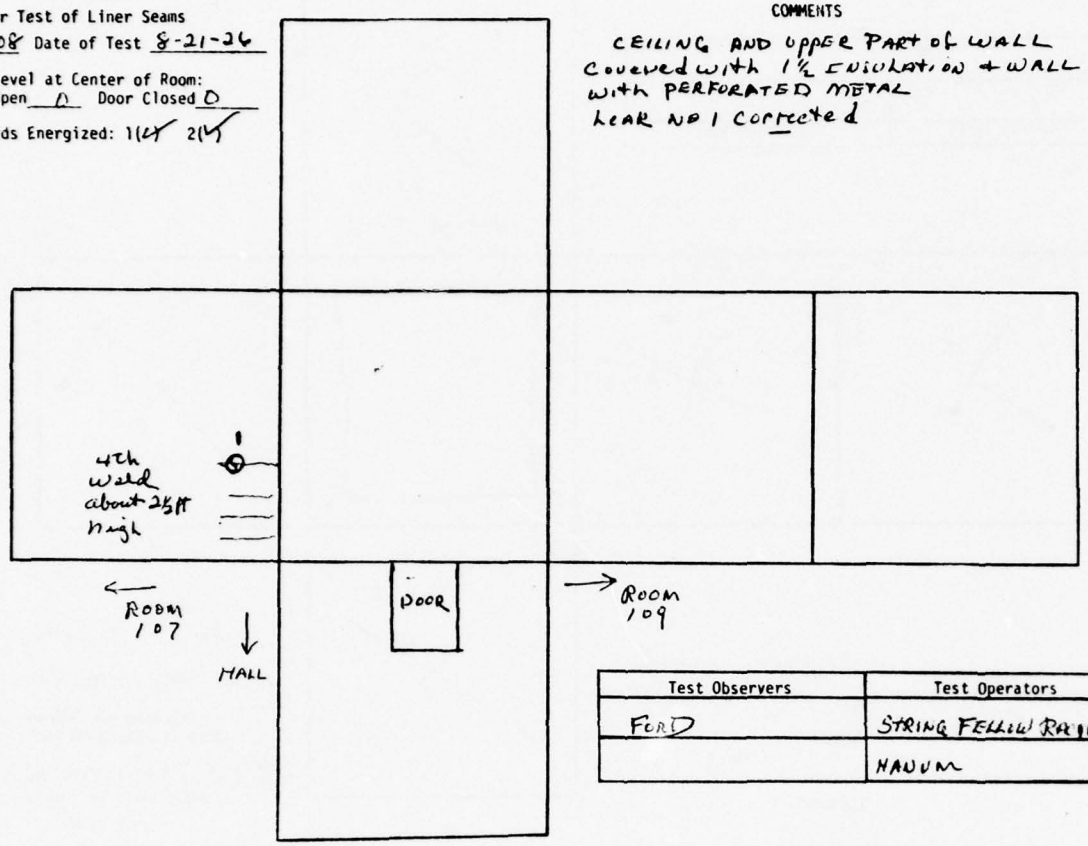
Room #108 Date of Test 8-21-26

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(L) 2(L)

COMMENTS

CEILING AND UPPER PART OF WALL
Covered with 1½ INSULATION + WALL
WITH PERFORATED METAL
LEAK NO 1 Corrected



Test Observers	Test Operators
FORD	STRING FELLOW RADCOR
	HANUM

Location	Level
1	7 DB

DATA SHEET

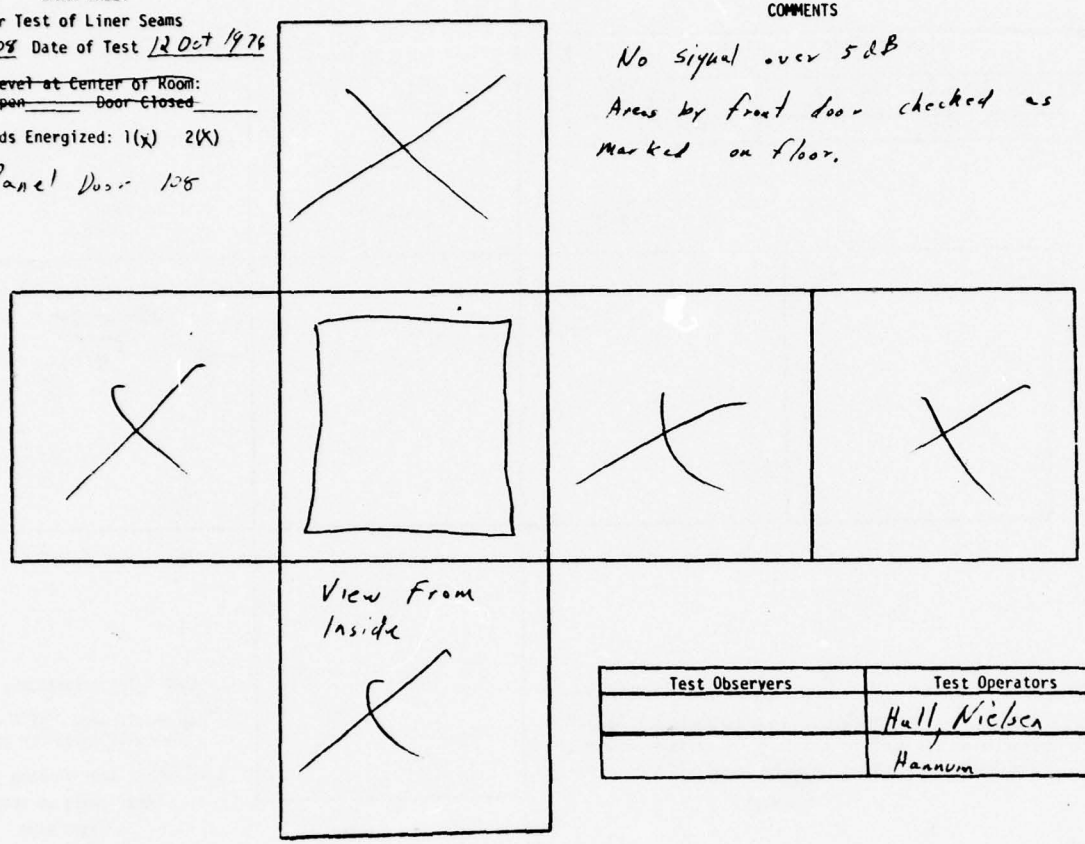
Sniffer Test of Liner Seams

Room # 108 Date of Test 12 Oct 1976

~~Signal Level at Center of Room:~~
~~Door Open _____ Door Closed _____~~

Test Leads Energized: 1(X) 2(X)

Panel Door 108



COMMENTS

No signal over 5 dB

Areas by front door checked as marked on floor.

Test Observers	Test Operators
	Hall, Nielsen
	Hannum

Location	Level

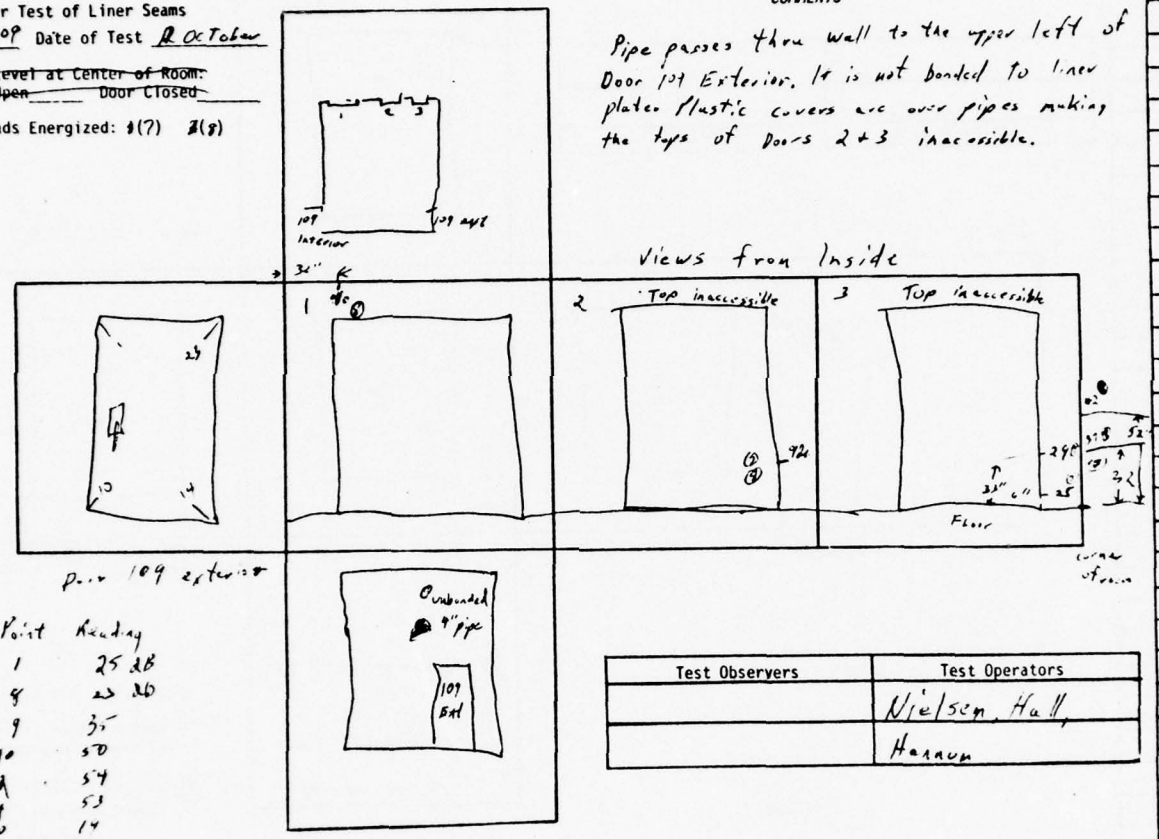
DATA SHEET

Sniffer Test of Liner Seams

Room # 109 Date of Test 2 October

~~Signal Level at Center of Room:~~
~~Door Open~~ ~~Door Closed~~

Test Leads Energized: #(7) #(8)



Point	Reading
1	25 28
4	23 26
9	35
10	50
12	54
19	53
20	14
03	42

COMMENTS

Pipe passes thru wall to the upper left of Door 109 Exterior. It is not bonded to liner plates. Plastic covers are over pipes making the tops of Doors 2 & 3 inaccessible.

Test Observers	Test Operators
	Nielsen, Hall
	Hannum

Location	Level

DATA SHEET

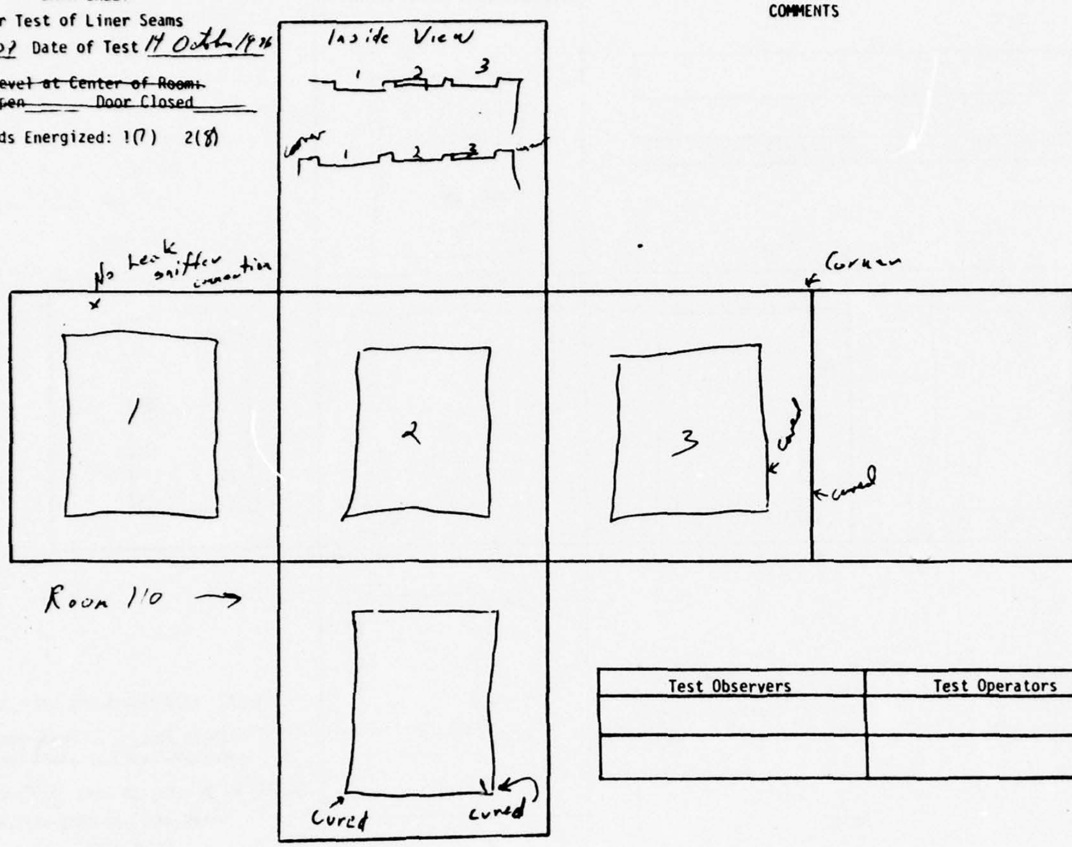
Sniffer Test of Liner Seams

Room # 10? Date of Test 14 October 1976

~~Signal Level at Center of Room:~~
~~Door Open~~ ____ Door Closed ____

Test Leads Energized: 1(7) 2(8)

COMMENTS



Test Observers	Test Operators

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

Room # 109 Date of Test 13 Oct 1976

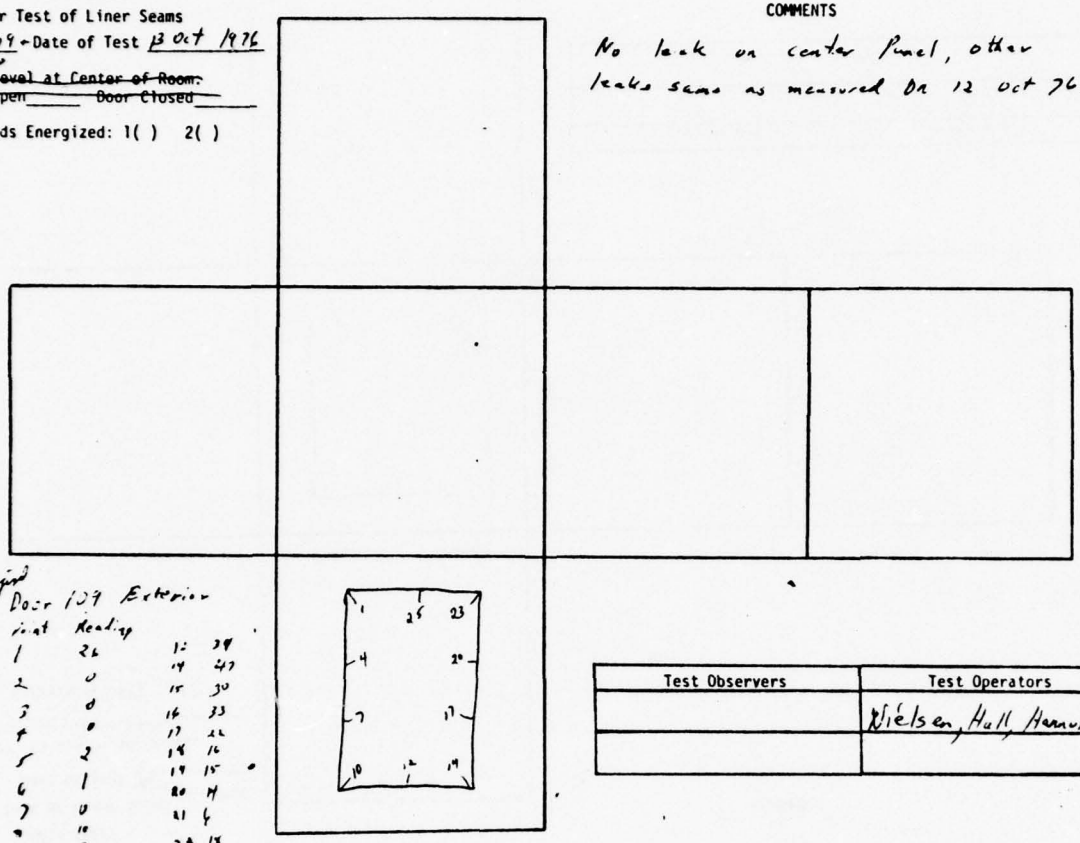
~~Signal Level at Center of Room:~~
~~Door Open____ Door Closed____~~

Test Leads Energized: 1( ) 2( )

COMMENTS

No leak on center Panel, other leaks same as measured On 12 Oct 76.

Location	Level



Door 109 Exterior

Point	Reading		
1	26	13	39
2	0	14	47
3	0	15	30
4	0	16	33
5	2	17	22
6	1	18	16
7	0	19	15
8	10	20	14
9	5	21	4
10	22	22	18
11	26	23	21
12	30	24	11
		25	17
		26	15

Test Observers	Test Operators
	Nielsen, Hall, Hanna

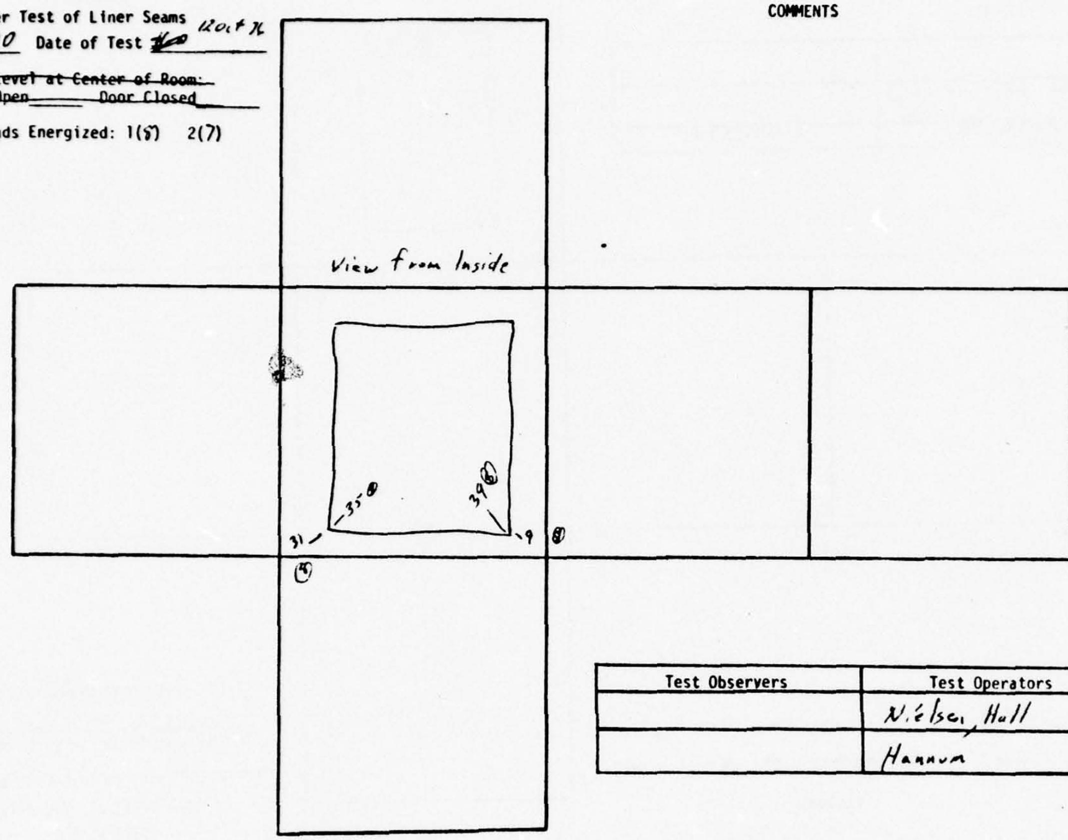
DATA SHEET

Sniffer Test of Liner Seams

Room # 110 Date of Test 12 Oct 76

~~Signal Level at Center of Room:~~
~~Door Open____ Door Closed____~~

Test Leads Energized: 1(8) 2(7)



COMMENTS

Test Observers	Test Operators
	Nielsen, Hull
	Hannum

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

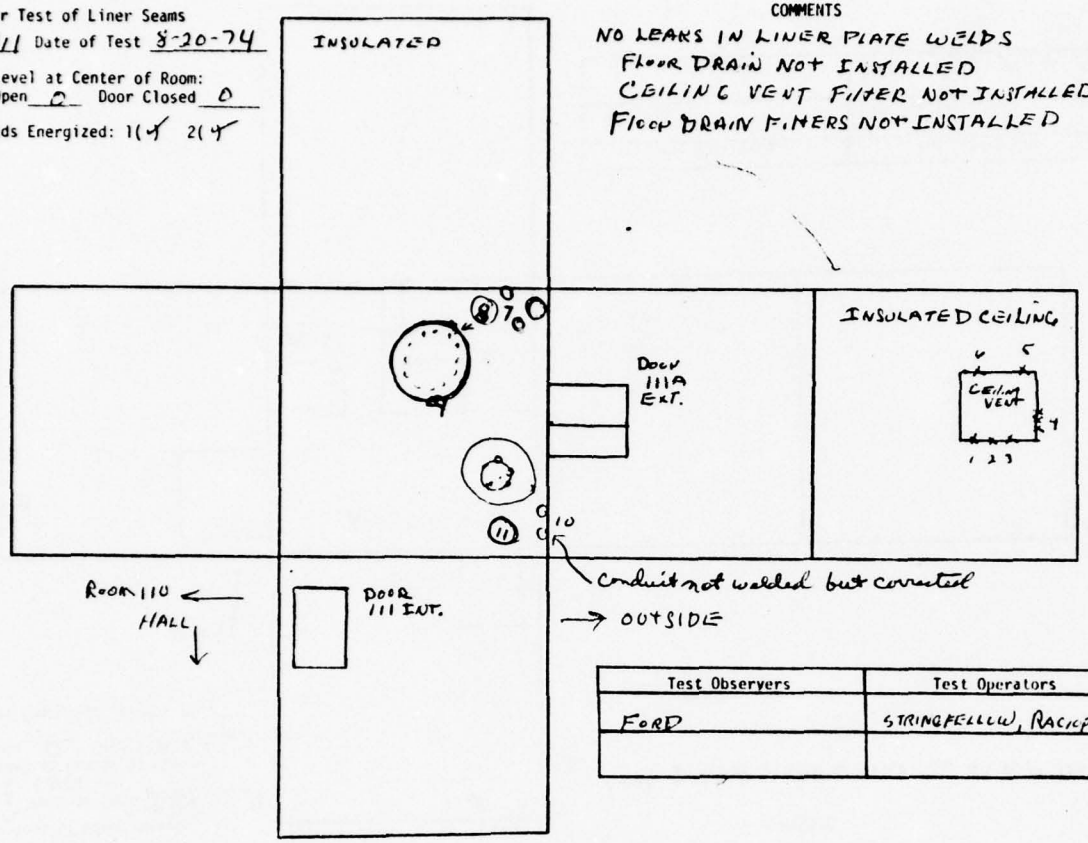
Room # 111 Date of Test 8-20-74

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(4 2(4

COMMENTS

NO LEAKS IN LINER PLATE WELDS
FLOOR DRAIN NOT INSTALLED
CEILING VENT FILTER NOT INSTALLED
FLOOR DRAIN FILTERS NOT INSTALLED



Location	Level
1, 2,	12 DB
3	16 DB
4	9 DB
5	16 DB
6	14 DB
7	26 DB
8	9 DB
9	36 DB
10	35 DB
11	32 DB

Test Observers	Test Operators
FORD	STRINGFELLOW, RACIOPPI

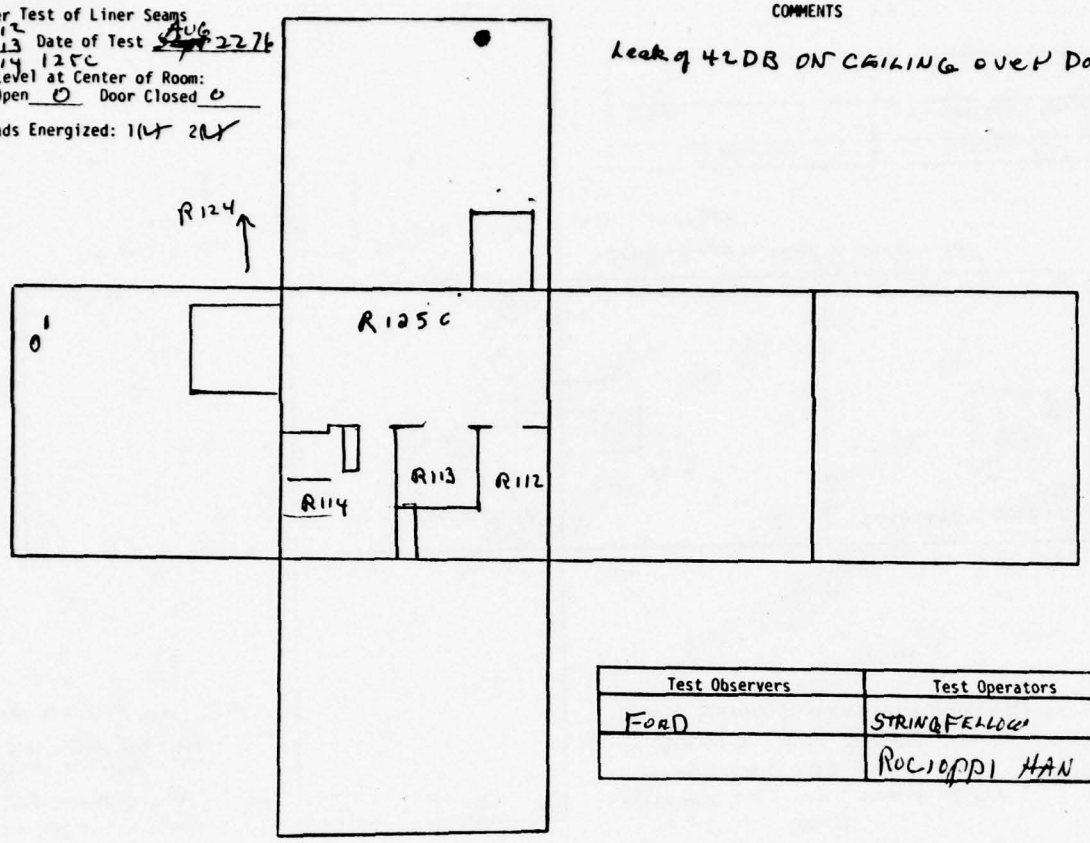
DATA SHEET

Sniffer Test of Liner Seams

Room # 112, 113, 114, 125C Date of Test AUG 2276

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(+) 2(+)



COMMENTS

Leak of 42DB ON CEILING OVER DOOR

Location	Level
1	42DB

Test Observers	Test Operators
FORD	STRINGFELLOW
	ROCIOPPI HANDEL

DATA SHEET

Sniffer Test of Liner Seams

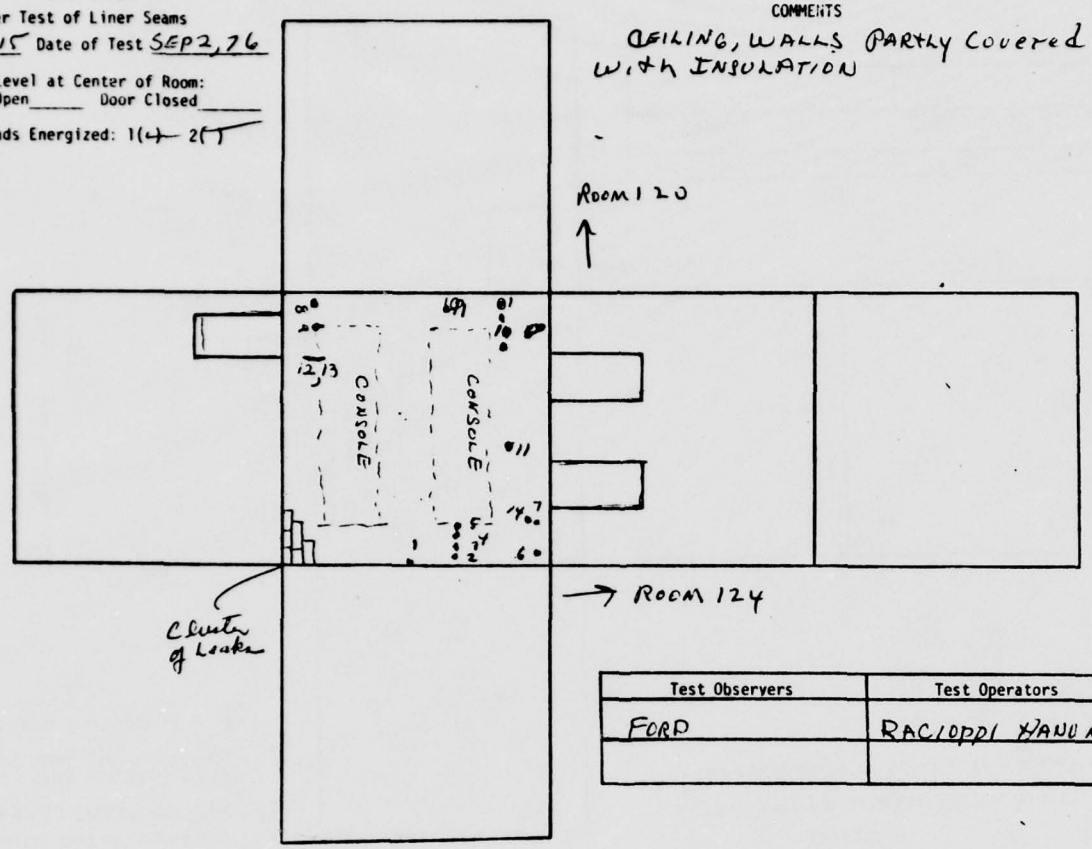
Room #115 Date of Test SEP 2,76

Signal Level at Center of Room:
Door Open_____ Door Closed_____

Test Leads Energized: 1(4) 2(T)

COMMENTS

CEILING, WALLS PARTLY Covered WITH INSULATION



Location	Level
1	19 DB
2	3 DB
3	2 DB
4	17 DB
5	15 DB
6	22 DB
7	20 DB
8	19 DB
9	19 DB
10	6 DB
11	22 DB
12	16 DB
13	16 DB
14	19 DB

Test Observers	Test Operators
FORD	RACIOPPI VANUM

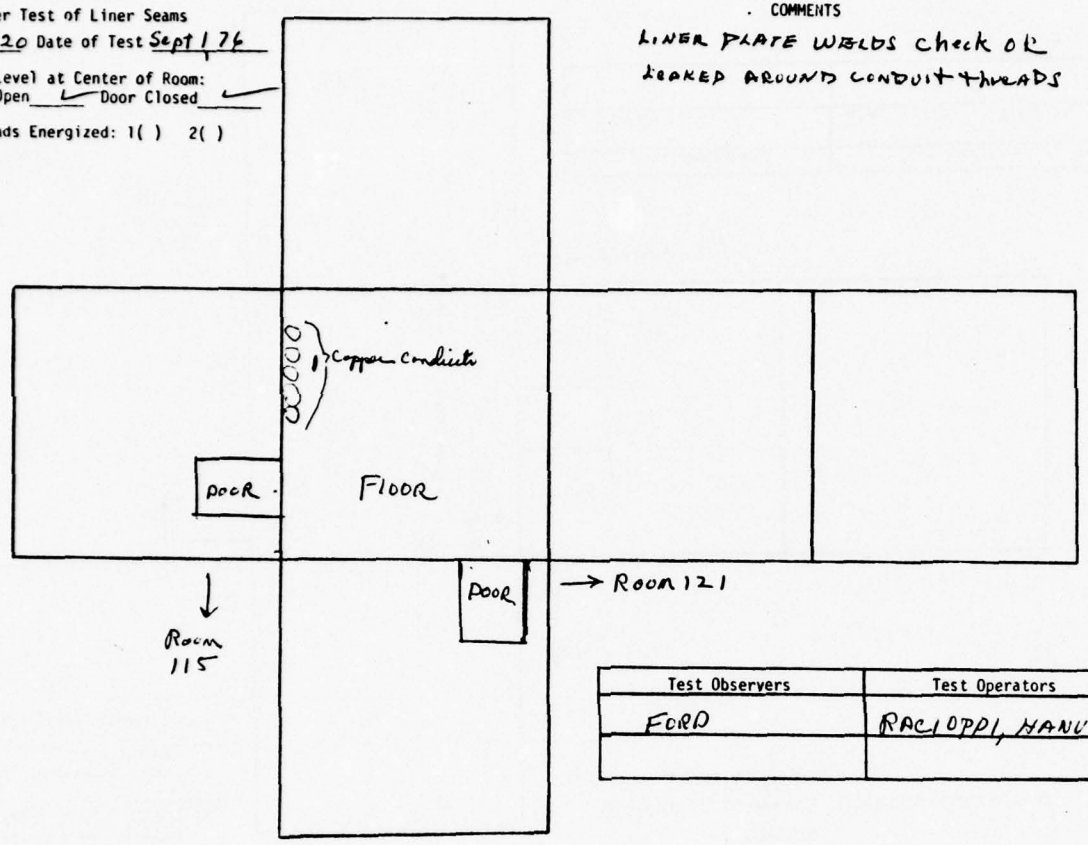
DATA SHEET

Sniffer Test of Liner Seams

Room #120 Date of Test Sept 1 76

Signal Level at Center of Room:
Door Open ___ Door Closed ✓

Test Leads Energized: 1( ) 2( )



COMMENTS

LINER PLATE WELDS check OK
LEAKED AROUND CONDUIT THREADS

Test Observers	Test Operators
FORD	RACIOPPI, HANUM

Location	Level
1	10 & 25 DB

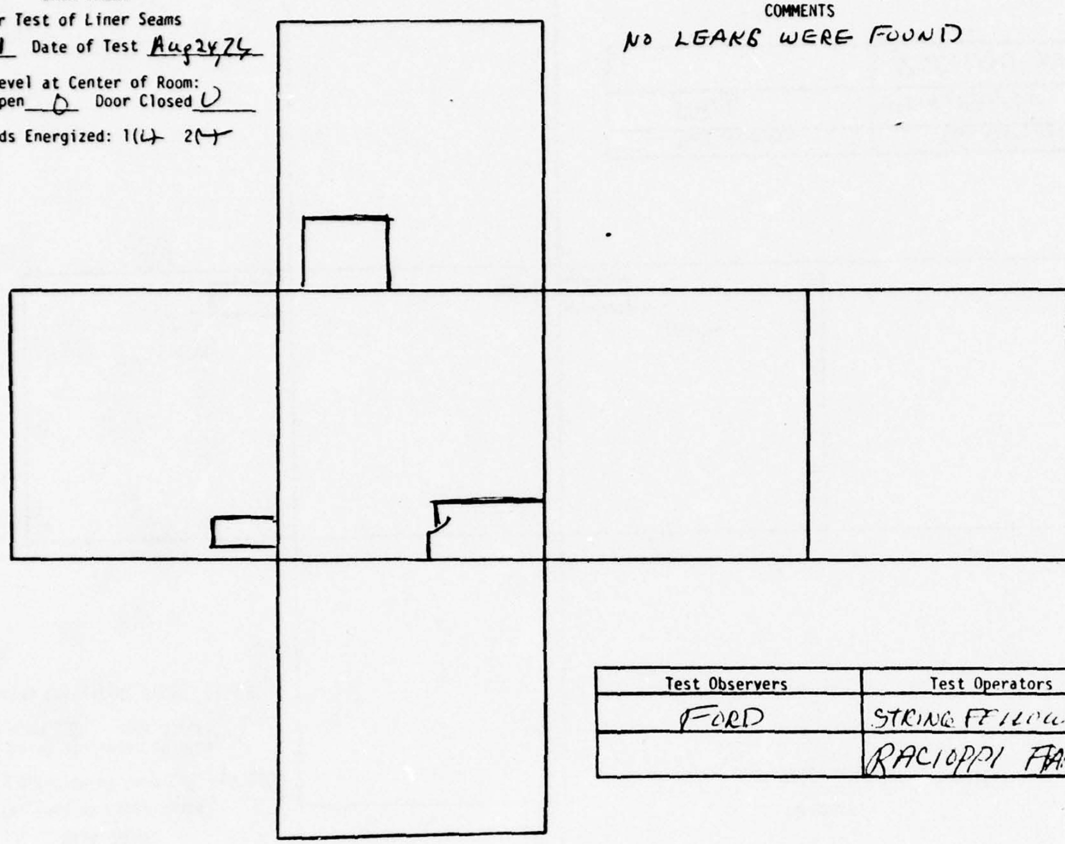
DATA SHEET

Sniffer Test of Liner Seams

Room #121 Date of Test Aug 24 76

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(+) 2(+)



COMMENTS

NO LEAKS WERE FOUND

Test Observers	Test Operators
FORD	STRINGFELLOW
	RACIOPPI FLANAGAN

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

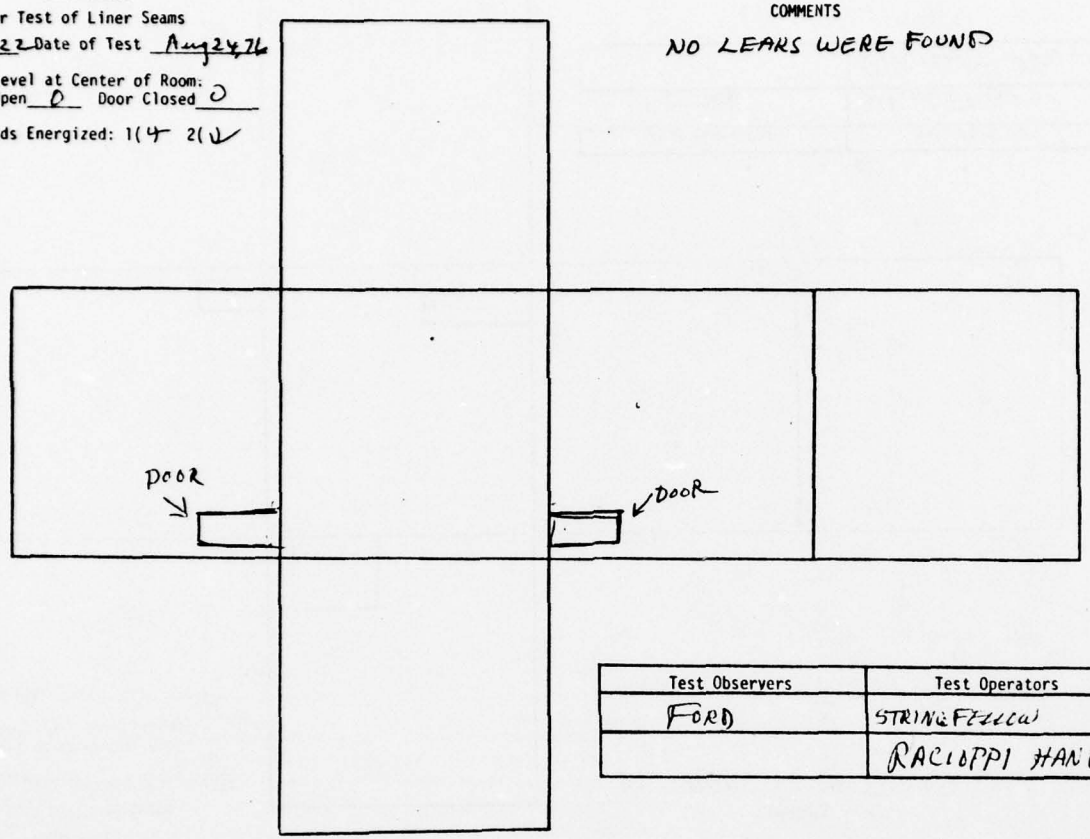
Room # 122 Date of Test Aug 24 76

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(4 2(✓

COMMENTS

NO LEAKS WERE FOUND



Test Observers	Test Operators
FORD	STRINGFELLOW
	RACIOPPI HANUA

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

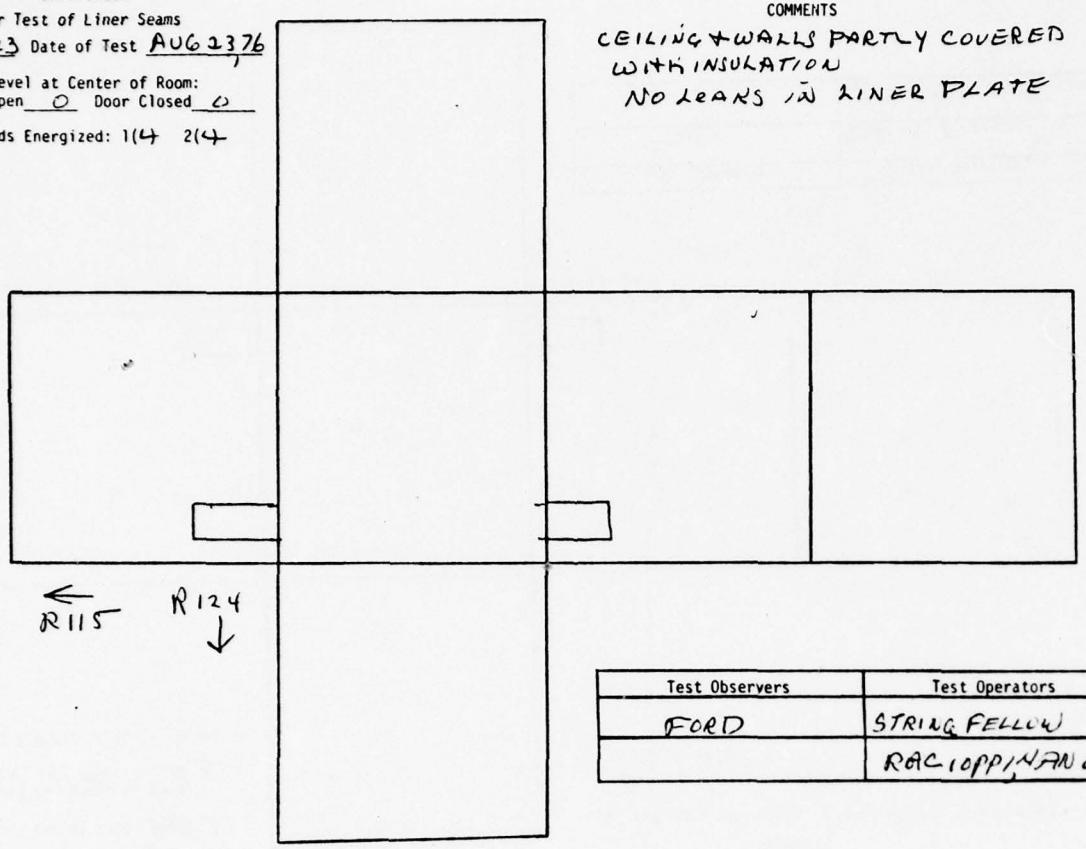
Room #123 Date of Test AUG 23 76

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(4 2(4

COMMENTS

CEILING + WALLS PARTLY COVERED WITH INSULATION
NO LEAKS IN LINER PLATE



Test Observers	Test Operators
FORD	STRING FELLOW
	RADIOPHANOM

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

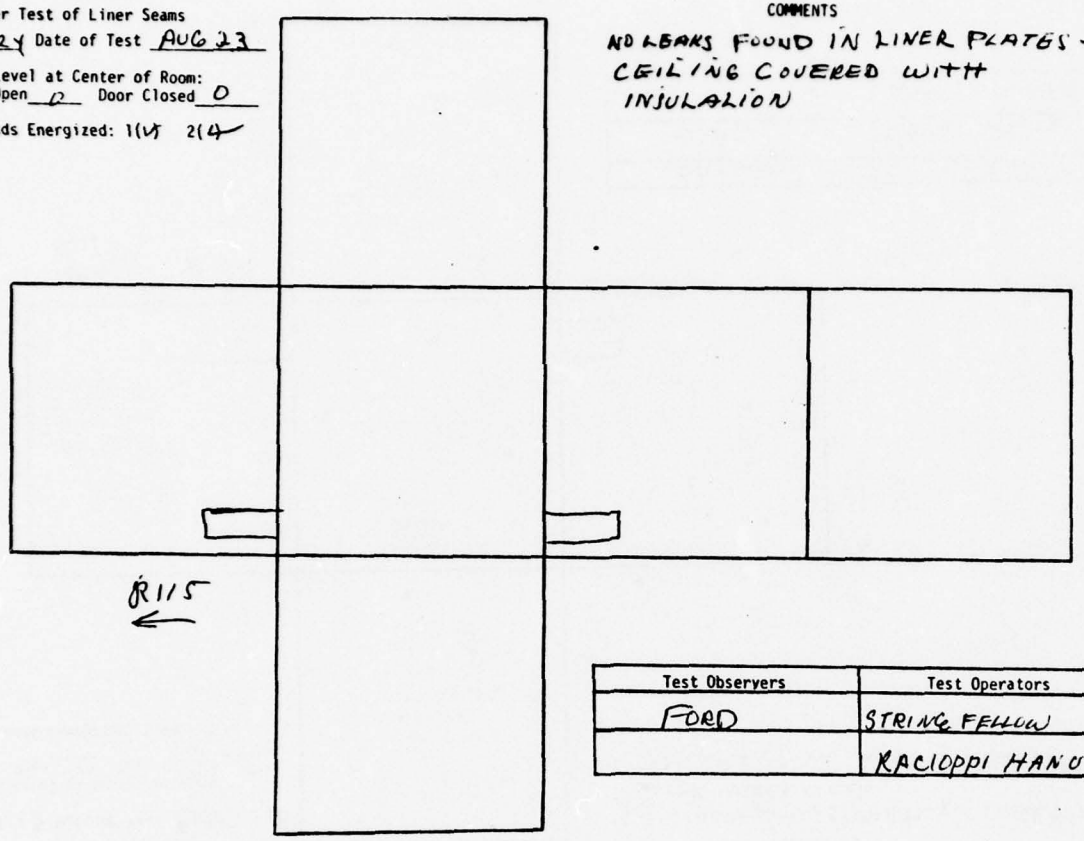
Room # 124 Date of Test AUG 23

Signal Level at Center of Room:
Door Open 2 Door Closed 0

Test Leads Energized: 1(✓) 2(✓)

COMMENTS

NO LEAKS FOUND IN LINER PLATES - CEILING COVERED WITH INSULATION



Test Observers	Test Operators
FORD	STRINGFELLOW
	RACIOPPI HANUM

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

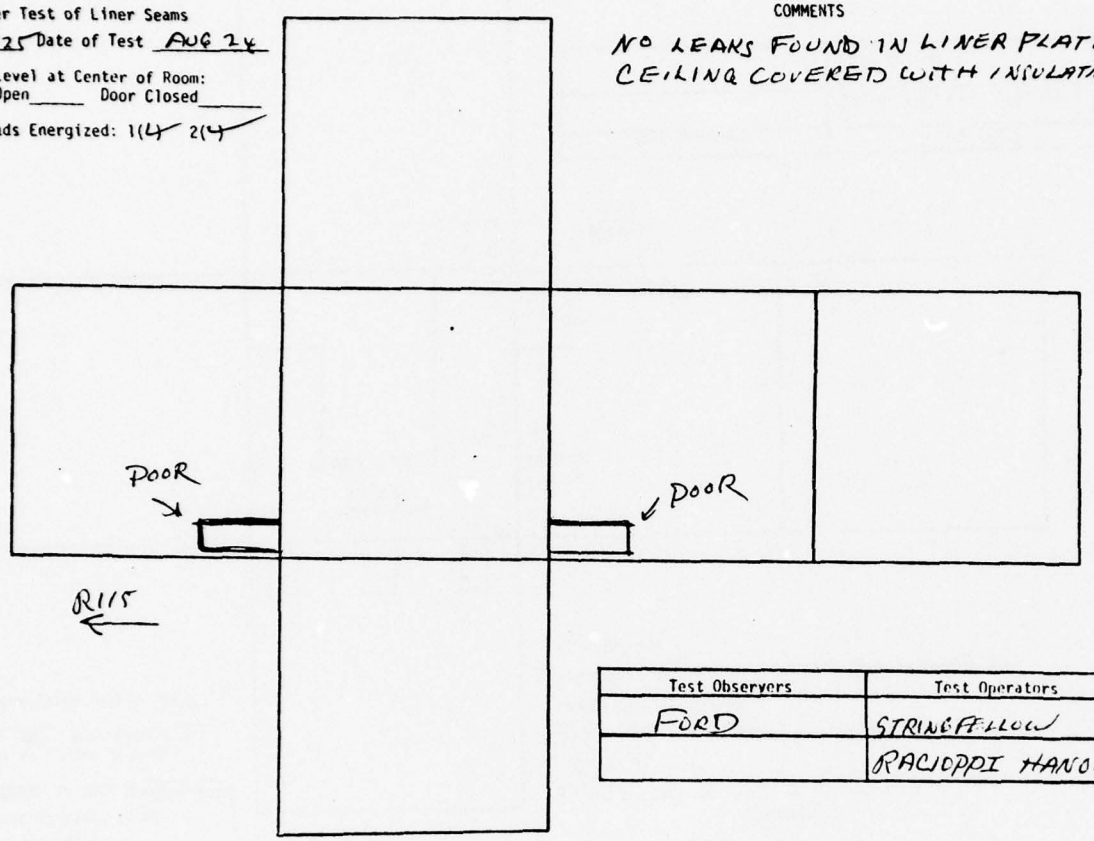
Room # 125 Date of Test AUG 24

Signal Level at Center of Room:
Door Open_____ Door Closed_____

Test Leads Energized: 1(4) 2(4)

COMMENTS

NO LEAKS FOUND IN LINER PLATE
CEILING COVERED WITH INSULATION



Test Observers	Test Operators
FORD	STRINGFELLOW
	RACIOPPI HANON

Location	Level

DATA SHEET

Sniffer Test of Liner Seams

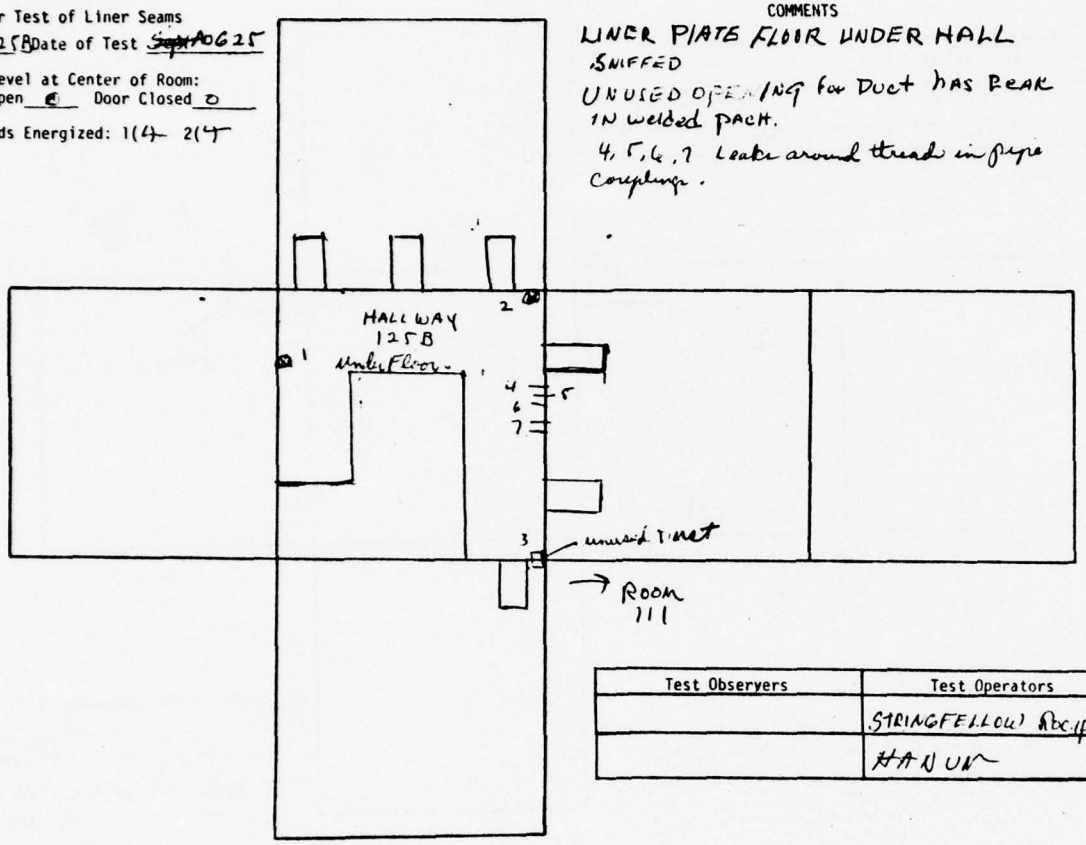
Room # 125B Date of Test ~~Sept~~ AUG 25

Signal Level at Center of Room:
Door Open 0 Door Closed 0

Test Leads Energized: 1(4 2(4

COMMENTS

LINER PLATE FLOOR UNDER HALL
SNIFFED
UNUSED OPENING for DUCT HAS LEAK IN welded PACH.
4, 5, 6, 7 Leaks around threads in pipe couplings.



Location	Level
1	20 DB
2	10 DB
3	50 DB
4	40 DB
5	30 DB
6	30 DB
7	45 DB

Test Observers	Test Operators
	STRINGFELLOW Rockwell
	HANUN

DATA SHEET

Sniffer Test of Liner Seams

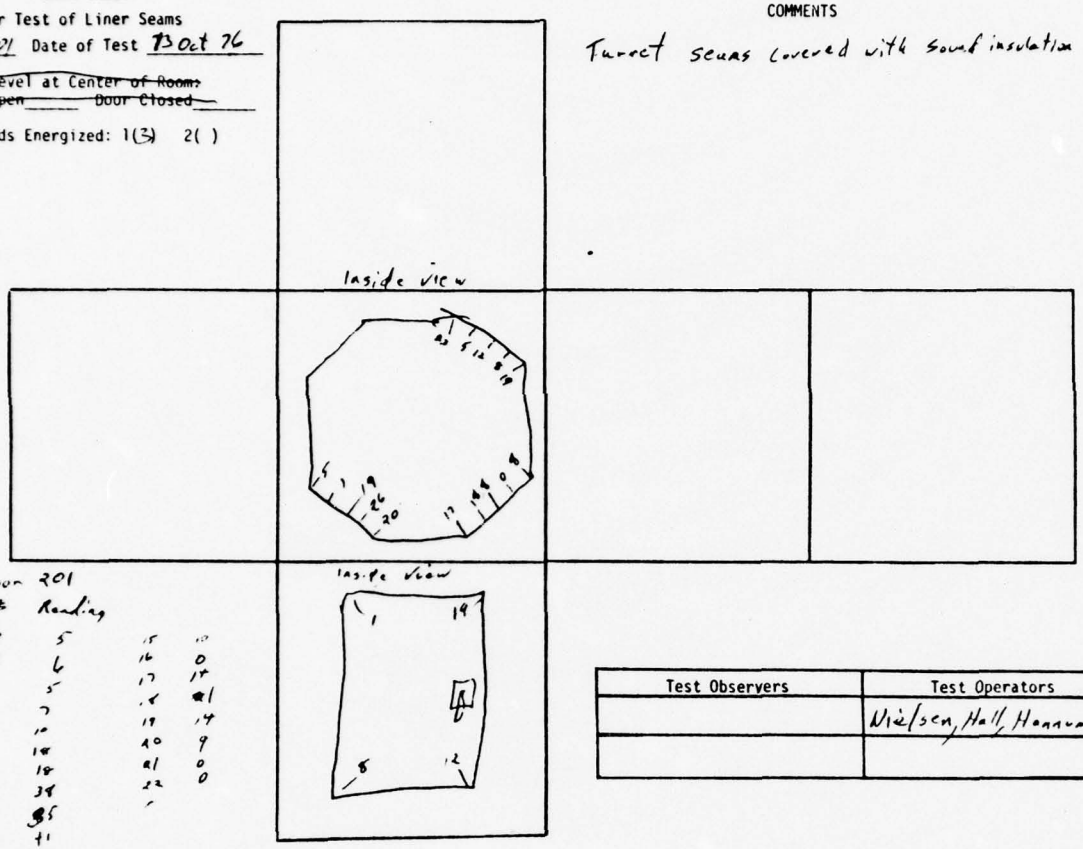
Room # 201 Date of Test 13 Oct 76

~~Signal Level at Center of Room:~~
~~Door Open_____ Door Closed_____~~

Test Leads Energized: 1(3) 2( )

COMMENTS

Turret seams covered with sound insulation



Door 201

#	Reading	#	Reading
1	5	15	10
2	6	16	0
3	5	17	14
4	7	18	11
5	10	19	14
6	14	20	9
7	18	21	0
8	38	22	0
9	85		
10	41		
11	54		
12	57		
13	31		
14	19		

Test Observers	Test Operators
	Nielsen, Hall, Hannum

Location	Level

APPENDIX C:

RF DOOR TEST RESULTS

This appendix presents the data sheets for the RF door tests. The data sheets are presented by door, in the following order:

Test Item 103
Location FOYER SWITCH
Date Sept 3, 1976

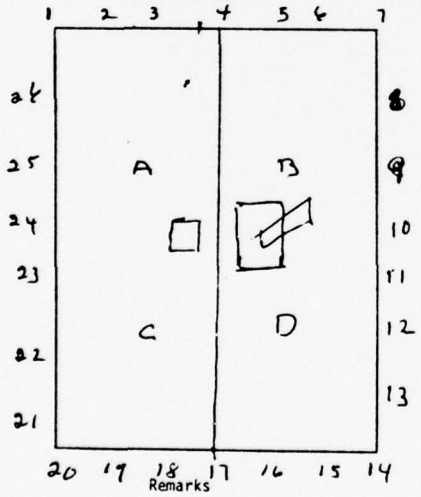
CERL
Data Sheet

Type 2
for shielded doors

	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl	-16	-1	-3	0	+10	+8
T Pt						
1	719	733	740	745	764	767
2½						
4						
5½						
7						
9						
11						
14						
15½						
17						
18½						
23						
25	↓	↓	↓	↓	↓	↓
Ref Lvl	-16	-1	-3	0	+0	+8

Attenuation in db						
Reqd.	6	20	40	40	40	67
Meas.	719	733	740	745	764	767

Test Item Sketch



	200kHz	1mHz	10mHz
Ref Lvl	-5	0	0
Test Pt			
1	770	770	770
3			
5			
7			
9			
11			
13			
15			
17			
19			
21			
23			
25			
27			
29			
31	↓	↓	↓
~~32~~			
~~34~~			
~~36~~			
~~38~~			
Ref Lvl	-5	0	0

Attenuation db			
Reqd.	67	67	67
Meas.	770	770	770

	100mHz	500mHz
Ref Lvl	0	0
Test Pt		
A	780	770
B		
C		
D	↓	↓
~~X~~		
Ref Lvl		

Attenuation db		
Reqd	67	67
Meas.	780	770

	2.5gHz	7gHz
Ref Lvl	0	0
Test Pt	770	770
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32	↓	↓
~~33~~		
~~34~~		
~~35~~		
~~36~~		
~~37~~		
~~38~~		
~~39~~		
~~40~~		
Ref Lvl		

Attenuation db		
Reqd	67	67
Meas.	770	770

Test Operator Stanyfalling, Ford

Test Observers _____

Test Item 109
Location Room 151 - 256
Date Sept 2, 1974

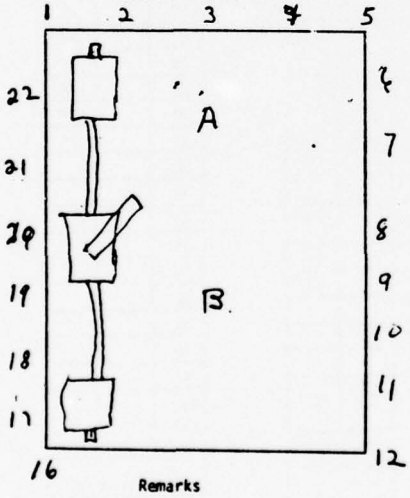
CERL
Data Sheet

Type 2
for shielded doors

	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl	-15	-3	-1	+1	+6	+10
T Pt						
1	729	740	745	749	756	759
3	↓	↓	↓	↓	↓	↓
5						
7						
9						
12						
14						
16						
18						
21	↓	↓	↓	↓	↓	↓
Ref Lvl	-15	-3	-1	+1	+6	+10

Attenuation in db						
Reqd.	6	20	40	~~40~~	~~40~~	59
Meas.	729	740	745	749	756	759

Test Item Sketch



Remarks

Noise level at 51DB

	200kHz	1mHz	10mHz
Ref Lvl	+70	+70	+70
Test Pt			
1	770	760	760
3	↓	↓	↓
5			
7			
9			
11			
13			
15			
17			
19			
21	↓	↓	↓
~~23~~			
~~25~~			
~~27~~			
~~29~~			
~~31~~			
~~33~~			
~~35~~			
~~37~~			
Ref Lvl	+70	+70	+70

Attenuation db			
Reqd.	59	59	59
Meas.	770	760	760

	2.5mHz	7.5mHz
Ref Lvl	60	60
Test Pt		
1	760	760
2	↓	↓
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22	↓	↓
~~23~~		
~~24~~		
~~25~~		
~~26~~		
~~27~~		
~~28~~		
~~29~~		
~~30~~		
~~31~~		
~~32~~		
~~33~~		
~~34~~		
~~35~~		
~~36~~		
~~37~~		
~~38~~		
~~39~~		
~~40~~		
Ref Lvl		

	100mHz	500mHz
Ref Lvl	60	60
Test Pt		
A	760	760
B	↓	↓
C		
~~D~~		
~~E~~		
Ref Lvl	60	60

Attenuation db		
Reqd	59	59
Meas.	760	760

Attenuation db		
Reqd	59	59
Meas.	760	760

Test Operator Stevenfellow, Floyd

Test Observers _____

Test Item Power Supply Exciter
Location Room 104
Date 4-5 October 76

CERL
Data Sheet

Type 2
for shielded doors

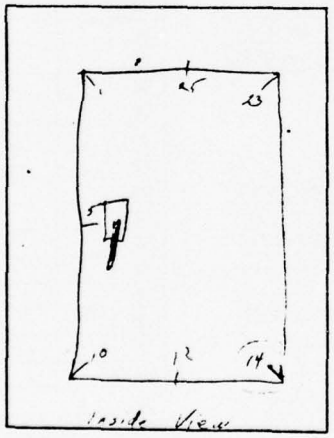
	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl	-14	0	+2	-3		81
T Pt						
1	-32	-30	-34	-38		32
4	-33	-34	-36	-40		26
7	-32	-34	-35	-44		27
10	-29	-26	-32	-38		35
12	-31	-29	-30	-42		32
14	-28	-28	-28	-34		33
17	-31	-32	-30	-46		31
20	-31	-35	-30	-48		27
23	-31	-32	-37	-44		25
25	-33	-34	-33	-44		29
Ref Lvl	-14	-3.5	+2	+3		81

Attenuation in db						
Reqd.	6	20	30	40		37
Meas.	14	24	30	40		37

HP400E Voltmeter

Shielded Enclosure

Test Item Sketch



Inside View

Remarks

N = Noise

Exciter Power Supply is sitting on floor

	200kHz	1mHz	10mHz
Ref Lvl	110	14	126
Test Pt			
1	35	30	18
3	16	22	16
5	25	18	15
7	23	15	13
9	35	38	28
11	45	37	32
13	42	34	25
15	45	35	20
17	35	25	18
19	33	15	19
21	30	16	17
23	33	14	15
25	34	24	17
27			
29			
31			
33			
35			
37			
39			
Ref Lvl	117	120	134

Attenuation db			
Reqd.	75	75	75
Meas.	76	81	82

Ailtech 707

	100mHz	500mHz
Ref Lvl	94	93
Test Pt		
A	17	N
B	12	5
C		
D		
E		
Ref Lvl	98	93

Attenuation db		
Reqd	75	75
Meas.	77	79

	2.5mHz	7mHz
Ref Lvl	123	77
Test Pt		
1	8	N
2	9	N
3	10	N
4	12	N
5	13	N
6	10	N
7	8	N
8	10	N
9	11	N
10	9	N
11	14	N
12	13	N
13	11	N
14	14	N
15	7	N
16	10	N
17	12	N
18	10	N
19	11	N
20	13	N
21	12	N
22	13	N
23	12	3
24	14	N
25	15	N
26	10	N
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
Ref Lvl	115	70

Attenuation db		
Reqd	75	75
Meas.	82	77

Test Operator Gulf Avionics Division

Test Observers _____

Test item Door 107 Exterior, Retest
Location Room 107
Date 13 Oct 1826

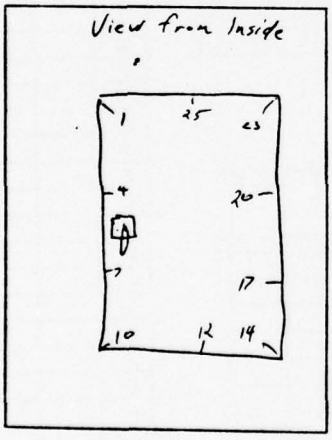
CERL Data Sheet

Type 2 for shielded doors

	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl			+1.5			+2
T Pt.						
1			-28			-40
4			-53			-48
7			-33			-44
10			-27.5			-38
12			-31			-42
14			-28			-35
17			-32			-40
20			-35			-37
23			-31			-44
25			-33			-45
Ref Lvl			+2			+3

Attenuation in db						
Reqd.						
Meas.			30			40

Test Item Sketch



Remarks

	200kHz	1mHz	10mHz
Ref Lvl			
Test Pt.			
1			
3			
5			
7			
9			
11			
13			
15			
17			
19			
21			
23			
25			
27			
29			
31			
33			
35			
37			
39			
Ref Lvl			

Attenuation db			
Reqd.			
Meas.			

	100mHz	500mHz
Ref Lvl		
Test Pt.		
A		
B		
C		
D		
E		
Ref Lvl		

Attenuation db		
Reqd		
Meas.		

	2.5gHz	7gHz
Ref Lvl		
Test Pt.		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
Ref Lvl		

Attenuation db		
Reqd		
Meas.		

Test Operator Nielsen, Hall, Hansen

Test Observers _____

Test Item Door 109 Exterior Retest
Location [illegible]
Date 17 October 1985

CERL
Data Sheet

Type 2
for shielded doors

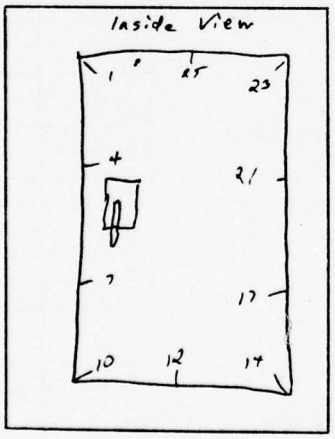
Test Pt.	60 Hz	400Hz	1kHz	[illegible]	9kHz	10kHz
Ref Lvl			+1.5	+1		
1			-26	30		
4			-34	-34		
7			-33	-34.5		
10			-27	-29.5		
12			-34	-34		
14			-26	-31.5		
17			-33	-31.5		
20			-31	-36		
23			-30	-34.5		
25			-33	-31.5		
Ref Lvl			+1.5	+1		
Attenuation in db						
Reqd.			40	40		
Meas.			28.5	29.5		

Test Pt.	200kHz	1mHz	10mHz
Ref Lvl			
1			
3			
5			
7			
9			
11			
13			
15			
17			
19			
21			
23			
25			
27			
29			
31			
33			
35			
37			
39			
Ref Lvl			
Attenuation db			
Reqd.			
Meas.			

Test Pt.	2.5gHz	7gHz
Ref Lvl		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
Ref Lvl		
Attenuation db		
Reqd		
Meas.		

Test Pt.	100mHz	500mHz
Ref Lvl		
A		
B		
C		
D		
E		
Ref Lvl		
Attenuation db		
Reqd		
Meas.		

Test Item Sketch



Remarks

Test #1: Moisture on Finger stock
Test #2: Dryed + Cleaned Finger-stock

Test Operator Hall, Nielsen

Test Observers _____

Test Item DOOR III INTERIOR
Location Room 117 125
Date 5 Oct 76

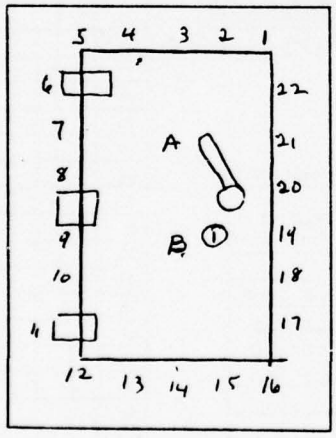
CERL
Data Sheet

Type 2
for shielded doors

	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl	-9	0	0	+4	+6	+10
T.Pt.						
1	-31	-36	48	50	54	56
3	-36	-38	50	50	52	54
5	-36	-32	48	50	50	50
7	-33	-32	46	50	50	50
9	-35	-30	46	48	48	48
12	-32	-32	46	48	48	48
14	-33	-34	50	48	48	50
16	-35	-40	46	50	54	54
19	-36	-38	46	50	50	56
21	-35	34	46	50	50	54
Ref Lvl	-9	0	0	+4	+6	+10

Attenuation in db						
Reqd.	4	20	40	40	40	48
Meas.	23	30	46	52	54	58

Test Item Sketch



Remarks

	200kHz	1mHz	10mHz
Ref Lvl	-7	90	70
Test Pt			
1	290	<0	<0
3	240		<10
5	<70		<10
7	<80		<10
9	<80		<0
11	<70		<0
13	<40		<10
15	85		<10
17	40		<10
19	<70		<10
21	80		<10
~~23~~			
~~25~~			
27			
29			
31			
33			
35			
37			
39			
Ref Lvl	-7	90	70

Attenuation db			
Reqd.	48	48	48
Meas.	72	290	260

	100mHz	500mHz
Ref Lvl	70	70
Test Pt		
A	<10	<0
B	<10	<0
C		
D		
E		
Ref Lvl	270	70

Attenuation db		
Reqd	48	48
Meas.	260	>70

	2.5gHz	7gHz
Ref Lvl	60	50
Test Pt		
1	<0	<0
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
~~23~~		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
~~40~~		
Ref Lvl	60	50

Attenuation db		
Reqd	48	48
Meas.	260	250

Test Operator Stirling Jackson, Ford
Test Observers John Kennamer

Test Item 111A EXTERIOR DOOR
Location 111A ROOM + OUTSIDE
Date SEPT 16, 1974

CERL Data Sheet

Type 2 for shielded doors

60 Hz 400Hz 1kHz 4.5kHz 9kHz 10kHz

Ref Lvl	-10	0	+3	+10	+20	+8
Test Pt.						
1	-56	-40	-40	-34	-38	-48
3	-40	-30	-40	-38	-38	-44
5	-30	-30	-38	-34	-36	-54
7	-30	-30	-38	-44	-36	-54
9	-32	-30	-38	-42	-50	-50
11	-32	-28	-39	-40	-34	-50
15	-30	-30	-38	-36	-34	-60
17	-30	-30	-38	-38	-34	-60
19	-30	-30	-39	-38	-34	-60
21	-30	-32	-38	-56	-36	-60
23	-30	-30	-38	-46	-36	-54
25	-30	-30	-38	-46	-36	-56
27	-30	-34	-38	-47	-54	-60
31	-30	-34	-40	-46	-58	-58
34	-30	-36	-40	-48	-52	-54
38	-30	-34	-38	-48	-52	-52
Ref Lvl	-10	0	+3	+10	+20	+8

Attenuation in db						
Reqd.	6	20	40	40	40	48
Meas.	20	28	41	44	54	52

200kHz 1mHz 10mHz

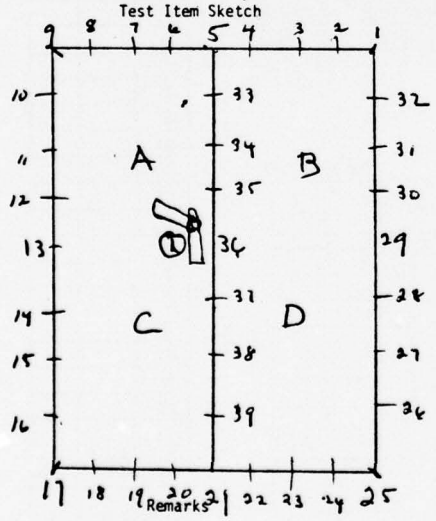
Ref Lvl	-5	70	70
Test Pt.			
1	>60	<10	<10
3			
5			
7			
9			
11			
13			
15			
17			
19			
21			
23			
25			
27			
29			
31			
33			
35			
37			
39	↓	↓	↓
Ref Lvl	48	48	48

Attenuation db			
Reqd.	48	48	48
Meas.	>55	>60	>60

2.5gHz 7gHz

Ref Lvl	70	60
Test Pt.		
1	<0	<0
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39	↓	↓
40		
Ref Lvl	70	60

Test Item Sketch



Door picture from outside Building.

100mHz 500mHz

Ref Lvl	60	70
Test Pt.		
A	<0	<0
B	<0	<0
C	<0	<0
D	<0	<0
E		
Ref Lvl		

Attenuation db		
Reqd	48	48
Meas.	>60	>70

Attenuation db		
Reqd	48	48
Meas.	>70	>60

Test Operator STRINGFELLOW, FRED, HANNUM

Test Observers _____

Test Item 125
Location Room 125, 4' catwalk 127
Date Sept 1 1976

CERL Data Sheet

Type 2 for shielded doors

	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl	-25	-10	-4	+1	+12	+12
T Pt.						
1	715	732	740	744	761	761
3						
5						
7						
9						
12						
14						
16						
18						
21						
Ref Lvl	-25	-10	-4	+1	+12	+12

Attenuation in db						
Reqd.	6	20	40	40	67	67
Meas.	715	732	740	744	761	761

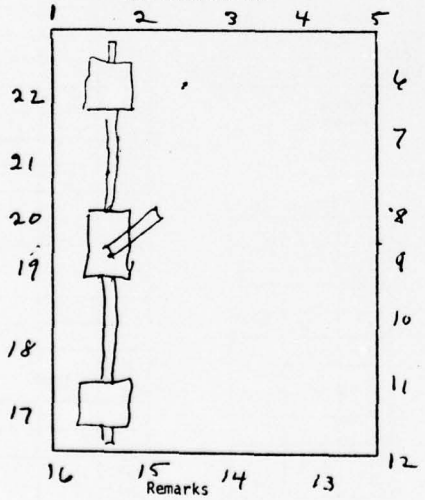
	200kHz	1mHz	10mHz
Ref Lvl	+0	+0	+0
Test Pt.			
1	790	7110	780
3			
5			
7			
9			
11			
13			
15			
17			
19			
21			
23			
25			
27			
29			
31			
33			
35			
37			
39			
Ref Lvl	0	0	0

Attenuation db			
Reqd.	67	67	67
Meas.	790	7110	780

	2.5gHz	7gHz
Ref Lvl	0	0
Test Pt.		
1	795	780
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
Ref Lvl		

Attenuation db		
Reqd	67	67
Meas.	795	780

Test Item Sketch



Remarks

	100mHz	500mHz
Ref Lvl	0	0
Test Pt.		
A	790	780
B	790	780
C		
D		
E		
Ref Lvl	0	0

Attenuation db		
Reqd	67	67
Meas.	790	780

Test Operator Stampfellow, Ford

Test Observers _____

Test Item Door 201, Exterior
Location Fort [illegible]
Date 19 October 19[illegible]

CERL Data Sheet

Type 2 for shielded doors

	60 Hz	400Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl	-41.5	-1	0	0.5	+3	+2
T.P.L.						
1	-32	-36	-40	-44	-56	-56
3	-32	-36	-41	-51	-54	-58
5	-31	-38	-40	-50	-36	-52
8	-28	-26	-33	-44	-48	-49
10	-30	-37	-35	-45	-47	-50
12	-24	-29	-34	-43	-48	-50
15	-32	-30	-40	-50	-57	-58
17	-58	-37	-41	-50	-54	-58
19	-36	-36	-31	-49	-50	-56
21	-33	-36	-42	-50	-53	-56
Ref Lvl	-14	-1	0	+0.5	+2	+2

Attenuation in db						
Reqd.	16	20	40	40	40	
Meas.	14	29	33	[illegible]	50	51

HP 400E

	200kHz	1mHz	10mHz
Ref Lvl	89	121	86
Test Pt.			
1	6	13	0
3	4	11	0
5	8	23	0
7	12	28	0
9	14	28	0
11	13	27	30
13	11	22	0
15	2	10	50
17	8	11	120
19	15	10	0
21	9	10	0
23			
25			
27			
29			
31			
33			
35			
37			
39			
Ref Lvl	89	122	86

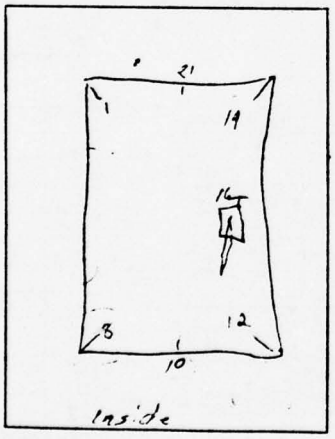
Attenuation db			
Reqd.	75	75	75
Meas.	74	44	28

Standing NARBY

	2.5gHz	5gHz
Ref Lvl	102	73
Test Pt.		
1	3	—
2	—	—
3	10	—
4	2	—
5	—	—
6	15	6
7	13	7
8	4	22
9	10	3
10	18	—
11	5	—
12	14	—
13	—	—
14	—	—
15	10	—
16	8	—
17	—	—
18	—	—
19	5	—
20	10	—
21	4	—
22	15	—
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
Ref Lvl	104	74

Attenuation db		
Reqd	75	75
Meas.	60	51

Test Item Sketch



	100mHz	500mHz
Ref Lvl	102	90
Test Pt.		
A	18	—
B	14	—
C		
D		
E		
Ref Lvl	112	93

Attenuation db		
Reqd	75	75
Meas.	94	93+

Remarks

Door Pops open

Fingerstock missing in corner with AR

Backside of Door has Fingerstock missing

Test Operator Hall, Nielsen

Test Observers _____

Test Item Door 201 Exterior Retest
Location Target
Date 13 Oct 78

CERL
Data Sheet

Type 2
for shielded doors

	60 Hz	300Hz	1kHz	4.5kHz	9kHz	10kHz
Ref Lvl			f1			+3
T Pt						
1			-40			-54
3			-43			-61
5			-41			-58
8			-36			-57
10			-36			-53
12			-35			-53
15			-42			-58
17			-42			-61
19			-38			-53
21			[illegible]			-58
			-42			
Ref Lvl			+15			+15

Attenuation in db						
Reqd.			40			
Meas.			36			52

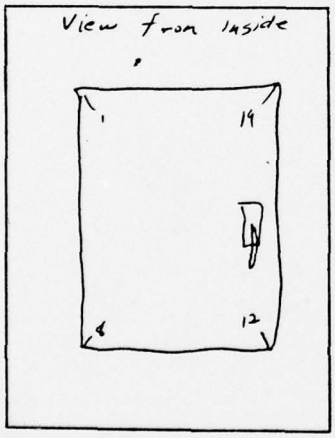
	200kHz	1mHz	10mHz
Ref Lvl			
Test Pt			
1			
3			
5			
7			
9			
11			
13			
15			
17			
19			
21			
23			
25			
27			
29			
31			
33			
35			
37			
39			
Ref Lvl			

Attenuation db			
Reqd.			
Meas.			

	2.5gHz	7gHz
Ref Lvl	104	76
Test Pt		
1	—	—
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	1	—
8	4	—
9	2	—
10	—	—
11	—	—
12	—	—
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	2	—
20	4	—
21	—	—
22	—	—
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
Ref Lvl	104	73

Attenuation db		
Reqd	75	75
Meas.	100	114

Test Item Sketch



Remarks

	100mHz	500mHz
Ref Lvl		
Test Pt		
A		
B		
C		
D		
E		
Ref Lvl		

Attenuation db		
Reqd		
Meas.		

Test Operator Hall, Hamm, Nielsen

Test Observers _____

APPENDIX D:

AIR DUCT FILTER TEST RESULTS

This appendix presents the air duct filter test data sheets by filter, in the following order:

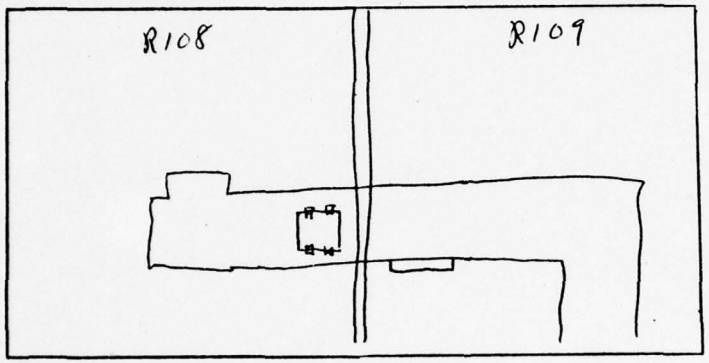
Test Item: AIR Duct FILTER
Location: 109 To 108
Date of Test: Sept 6, 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	[illegible]	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1											60		60
Meas Lvl											20		20
Ref Lvl 2											60		60
Attn Reqd	0	20	40	→	→	59	→	→	→	→	→	→	→
Attn Meas											760		760

Test Item Sketch



REMARKS

DUCT 9x15
DOOR 6x12

Test Operators STRINGFELLOW RACICPPI
Test Observers FORD

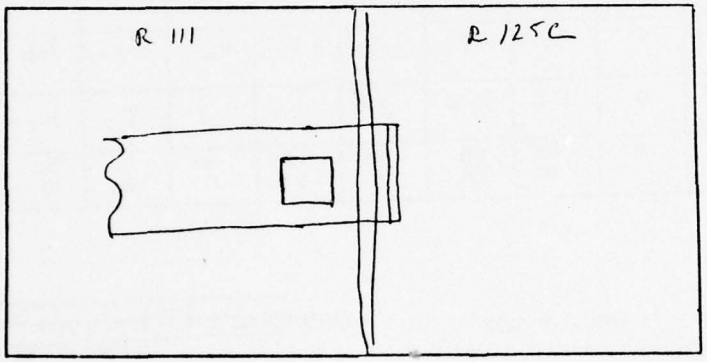
Test Item: AIR DUCT FILTER
Location: R111 to 125C
Date of Test: Sept 6, 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1	≀	≀	≀	≀	≀	≀	-5	118	60	80	60	≀	50
Meas Lvl	≀	≀	≀	≀	≀	≀	-75	<54	<50	<10	<0	≀	<0
Ref Lvl 2	≀	≀	≀	≀	≀	≀	-5	118	60	80	60	≀	50
Attn Reqd	6	12	40			48	→						
Attn Meas							780	764	750	770	760		750

Test Item Sketch



REMARKS

DUCT SIZE 22×22
FILTER SIZE 17 1/4 × 14

Test Operators RACLEPPI, STRINGFELLOW
Test Observers RAFF FORD

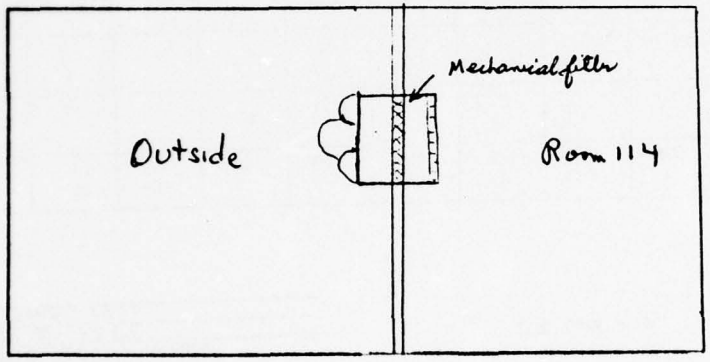
Test Item: Air Duct Filter
Location: Room 114 South Wall to Outside
Date of Test: September 11, 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1	-14	-2	1	+4	+8	+6	-2	70	70	70	70	70	70
Meas Lvl	44	-62	-70	-68	-68	-68	<-90	<0	<0	<0	<0	<0	<0
Ref Lvl 2	-14	-2	1	+4	+8	+6	-2	70	70	70	70	70	70
Attn Reqd	6	20	40	40	67	67	67	67	67	67	67	67	67
Attn Meas	30	60	69	72	76	74	>88	>70	>70	>70	>70	>70	>70

Test Item Sketch



REMARKS

Test Operators Springfield Rawlyp! FLRD
Test Observers

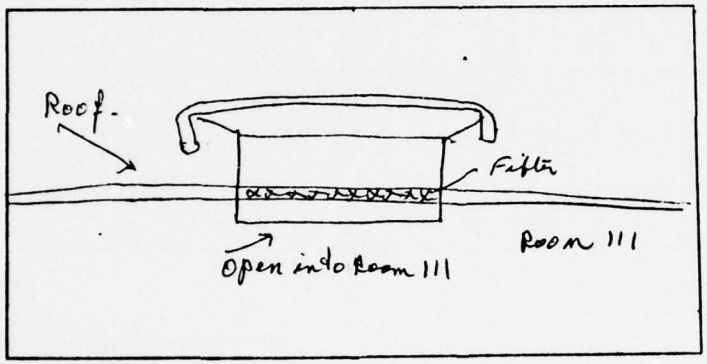
Test Item: AIR DUCT FILTER
Location: Room 111 & Roof.
Date of Test: Sept 9, 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1	-13	-4	-1	+3	+6	+2	-5	70	70	90	80	70	60
Meas Lvl	-48	-48	-50	-50	-48	-50	7-90	∠0	∠6	∠10	∠0	∠0	∠0
Ref Lvl 2	-13	-4	-1	+3	+6	+2	-5	70	70	90	80	70	60
Attn Reqd	6	20	40	40	40	31	31	31	31	31	31	31	31
Attn Meas	35	+44	+49	53	54	52	785	770	770	780	780	770	760

Test Item Sketch



REMARKS

Test Operators Stumpf, Fellows, Ravizza, Ford
Test Observers

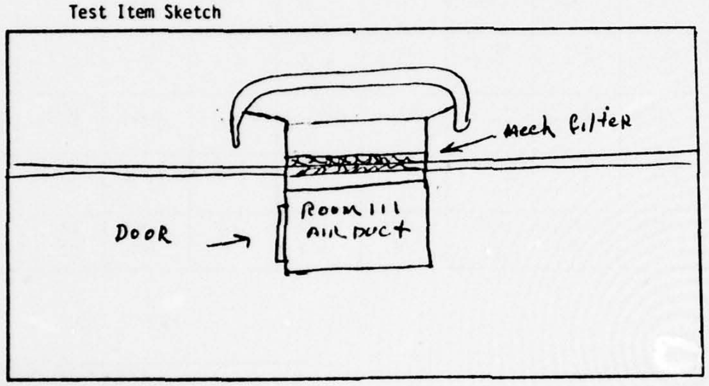
Test Item: AIR DUCT FILTER
Location: Room 111 + Roof
Date of Test: Sept 9, 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1	-10	-4	-1	+3	+6	+2	-5	70	70	70	60	70	70
Meas Lvl	< -60	< -60	< -64	< -68	< -70	> -50	> -90	< 0	< 10	< 10	< 0	< 0	< 0
Ref Lvl 2	-10	-4	-1	+3	+6	+2	-5	70	70	70	60	70	70
Attn Reqd	6	20	40	40	40	31	31	31	31	31	31	31	31
Attn Meas	50	56	63	71	76	52	85	70	60	60	60	70	70

Test Item Sketch



REMARKS

Test Operators [illegible]
Test Observers

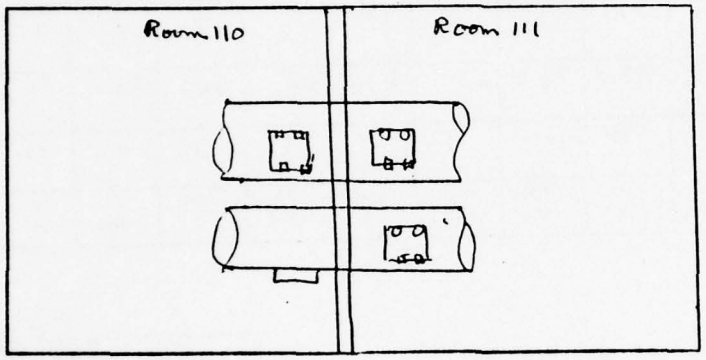
Test Item: AIR DUCT Filter
Location: Room 111 to Room 110
Date of Test: Sept 5 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1							-5	100	70	70	70	70	60
Meas Lvl							>90	<40	<0	<10	<10	<10	<10
Ref Lvl 2							-5	100	70				
Attn Reqd							48	48	48	48	48	48	48
Attn Meas							785	>60	770	760	760	760	750

Test Item Sketch



REMARKS

Test Operators Stringfellow Finch
Test Observers Rawdon

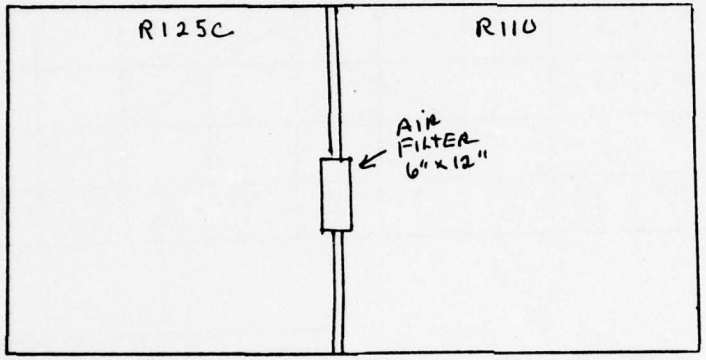
Test Item: AIR FILTER
Location: Room 110 & 125C
Date of Test: Sept 5 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1	-12	-2	0	3	6	4	-5	100	70	70	70	70	60
Meas Lvl	-36	-48	-48	-54	-59	-59	>90	<40	<0	<0	<0	<0	<0
Ref Lvl 2	-12	-2	0	3	6	4	-5	100	70	70	70	70	70
Attn Reqd	60	20	40	40	48	59	59	59	59	59	59	59	59
Attn Meas	>24	46	48	>60	65	63	>85	>60	>70	>70	>70	>70	>60

Test Item Sketch



REMARKS

Test Operators STRINGFELLOW, FORD
KADANOF
Test Observers

APPENDIX E:

ELECTRICAL FILTER TEST RESULTS

This appendix presents the data sheets for the electrical filter tests. The data sheets are arranged by filter, in the following order:

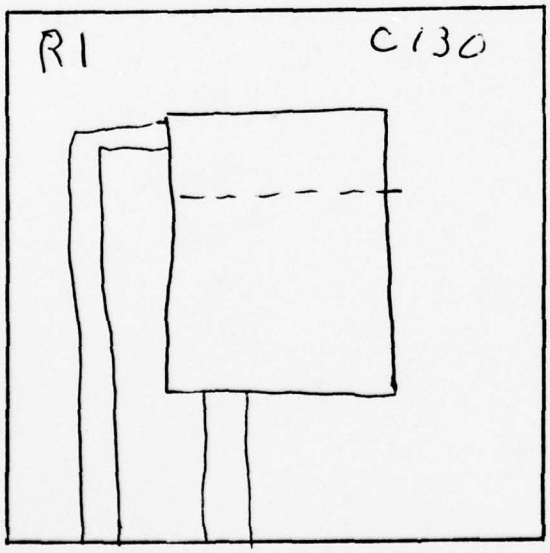
Type 4
for electrical
filters.

CERL Data Sheet

ELECTRICAL FILTER R1
Room 111

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	80	80
Meas Lvl	>90	~~<~~ 0	<0
Ref 2	-5	~~>~~ 80	80
Reqd Attn	20DB	48DB	48DB
Meas Attn	>85DB	>80	>80DB

Test Item Sketch



REMARKS

Test Operators: STRINGFELLOW, FORD, KAVANOG

Test Observers: _____

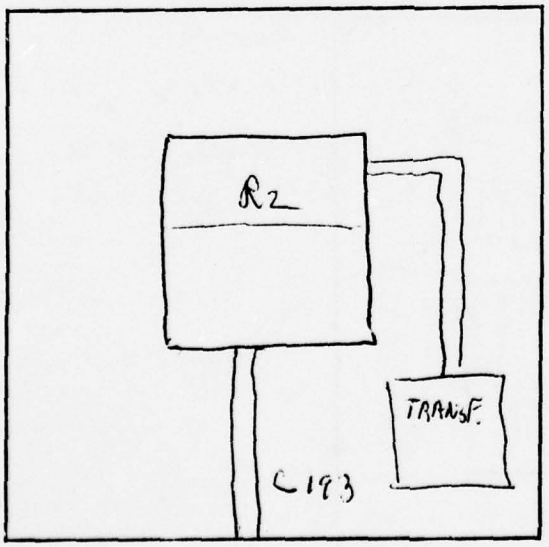
Type 4
for electrical
filters and conduit

CERL Data Sheet

ELECTRICAL FILTER R2
ROOM 111

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	80	80
Meas Lvl	>90	<0	<0
Ref 2	-5	80	80
Reqd Attn	20 DB	48DB	48DB
Meas Attn	>85DB	>80DB	>80DB

Test Item Sketch



REMARKS

Test Operators: STRINGFELLOW, FORD, KAUANOE

Test Observers: _____

Type 4
for electrical
filters and conduit

Test Item: Filter #3

CERL Data Sheet

8 October 1976

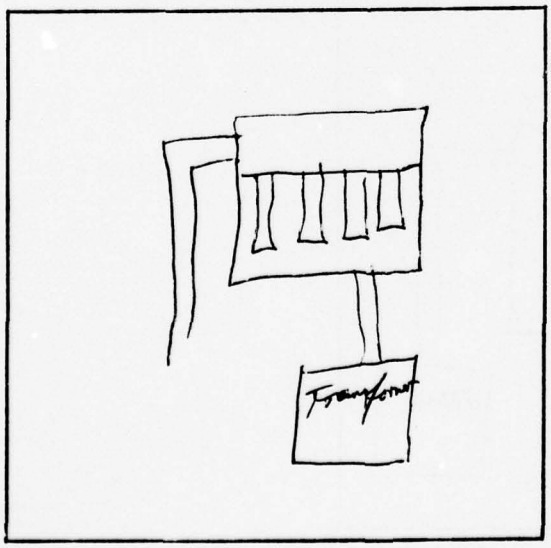
Item Location: Room 111

Test Location: Radiate + Filter room 111

Receive — L114 under hallway elbow conduit.

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	91 dB	90dB	95 dB
Meas Lvl	Noise Level -10dB	Noise ×10dB	32 dB
Ref 2	90 dB	90 dB	96 ~~95~~ dB
Reqd Attn	48dB	48dB	48dB
Meas Attn	100 dB	80dB+	62

Test Item Sketch



REMARKS

200kHz Noise Level in hallway = -33 dB under hallway = -13 dB

area B & C

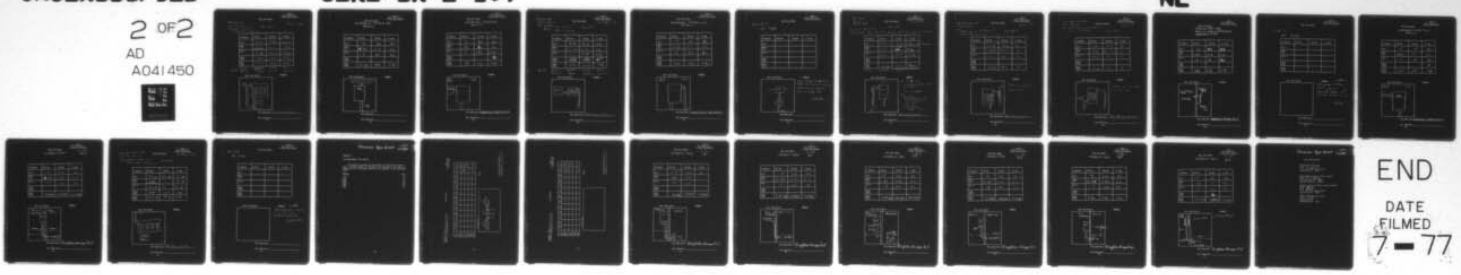
Test Operators: Hall, Hannum, Nielsen

Test Observers: _____

AD-A041 450 CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAI--ETC F/G 9/1
RADIO FREQUENCY SHIELDING TESTS OF SYSTEM TECHNOLOGY TEST FACIL--ETC(U)
JUN 77 P H NIELSEN

UNCLASSIFIED CERL-SR-E-107 NL

2 OF 2
AD
A041 450



END

DATE
FILMED
7-77

Type 4
for electrical
filters and conduit

CERL Data Sheet

Test Item: R4

7 October 1978

Item Location: Room 111

Zone B to C

Test: Radiate - Filter Room 111

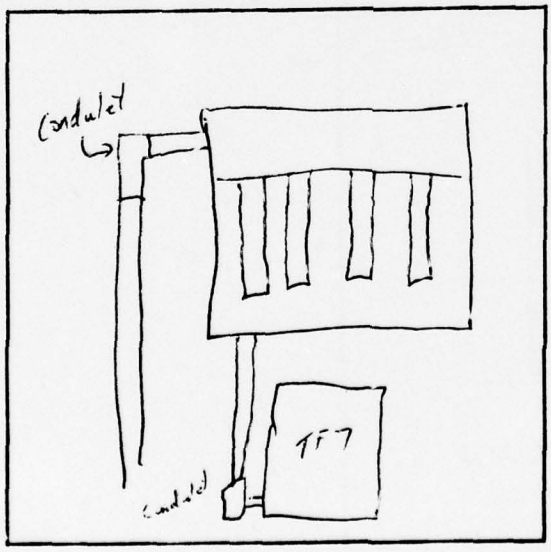
Receive - PP4 Room 115

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	93 dB	97 dB	95 dB
Meas Lvl	-10 dB Room Noise	Noise	7 dB
Ref 2	93 dB	92 dB	94 dB
Reqd Attn	48 dB	48 dB	48 dB
Meas Attn	103 dB+	59 dB+	87 dB

Equipment: Radiate: HP 8601A ENI Amplifier | Gen Radio | Hitech

Receive: NM12AT | Hitech 707 | Hitech 707

Test Item Sketch



REMARKS

Test Operators: H. J. Hamstra, Nielsen

Test Observers: _____

Type 4
for electrical
filters and conduit

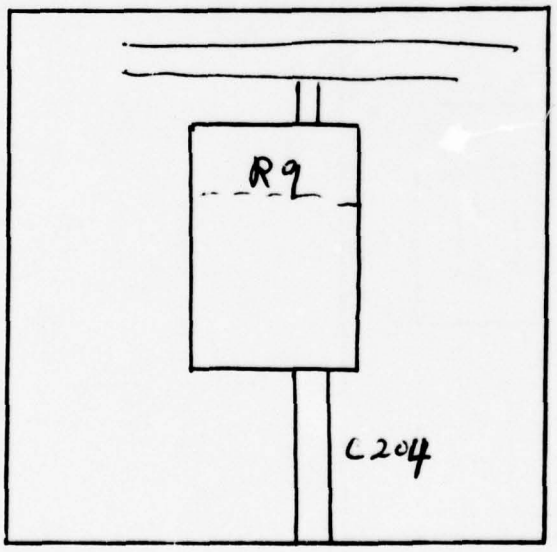
CERL Data Sheet

ELECTRICAL FILTER R9

Room 111

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-7	80	80
Meas Lvl	83	L O	L O
Ref 2	-7	80	80
Reqd Attn			
Meas Attn	>76	>80	>80

Test Item Sketch



REMARKS

Test Operators: _____

Test Observers: _____

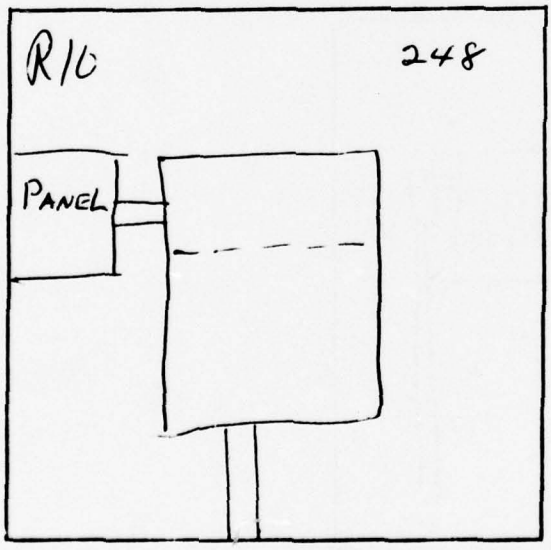
Type 4
for electrical
filters and conduit

CERL Data Sheet

ELECTRICAL FILTER R10
Room 111

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-3	80	80
Meas Lvl	-90	60	60
Ref 2	-3	>80	>80
Reqd Attn			
Meas Attn	87	>80	>80

Test Item Sketch



REMARKS

Test Operators: STRINGFELLOW, FORD, RADANOE

Test Observers: _____

Type 4
for electrical
filters and conduit

Test Item: R11

Location: Room 111

CERL Data Sheet

7 October 1976

Test: Radiate: Filter in Room 111 Zone B to C

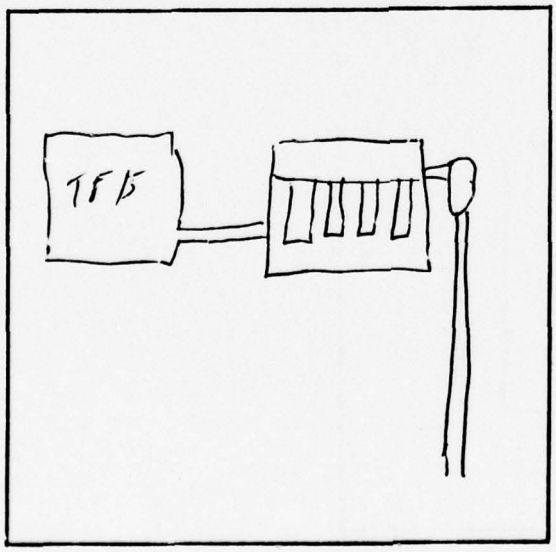
Receive: outlet in Room 122

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	87dB	89 dB	95dB
Meas Lvl	Noise = 3dB	≈ 1 dB	2 dB
Ref 2	90 dB	88dB	95dB
Reqd Attn	~~120dB~~ 48 dB	~~Set dB~~ 48dB	~~Set dB~~ 48dB
Meas Attn	120dB +	87 dB	93dB

Equipment

Radiate:	HP 8601A ENI	Gen Radio	Biltech
Receive:	NM 12AT	Biltech 707	Biltech 707

Test Item Sketch



REMARKS

Test Operators: Hall, Hamilton, Nielsen

Test Observers: _____

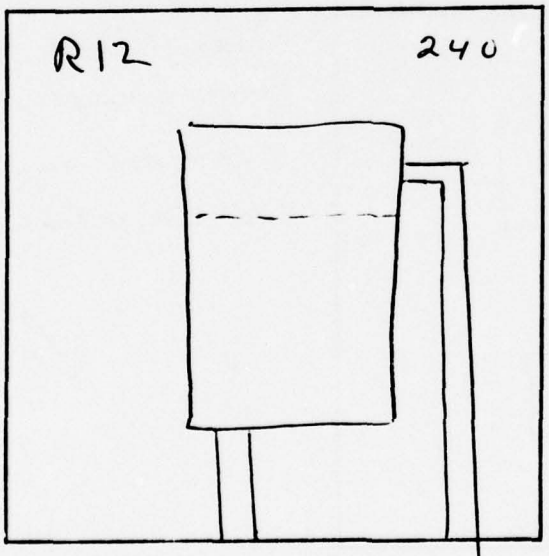
Type 4
for electrical
filters and conduit

CERL Data Sheet

ELECTRICAL FILTER R12
ROOM 111

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	80	80
Meas Lvl	∠-90	∠0	∠0
Ref 2	-5	80	80
Reqd Attn			
Meas Attn	>85	>80	>80

Test Item Sketch



REMARKS

Test Operators: STRING FELLOW, FORD MAVANCE

Test Observers: _____

Type 4
for electrical
filters and conduit

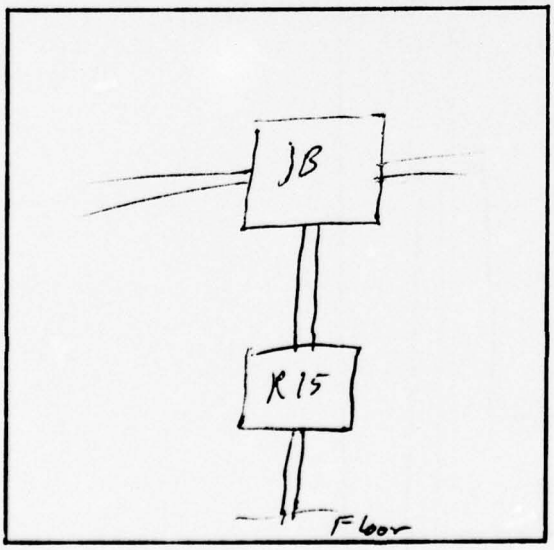
CERL Data Sheet

Item: RF 15

Not tested

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1			
Meas Lvl			
Ref 2			
Reqd Attn			
Meas Attn			

Test Item Sketch



REMARKS

Wires leading to external alarm circuitry not connected

Item not available for test, 10 October 1976

F. Nielsen

Test Operators: _____

Test Observers: _____

Test Item

R 17, FILTER

CERL Data Sheet

Type 4
for electrical
filters and conduit
5 Oct. 1976

Zones A to B

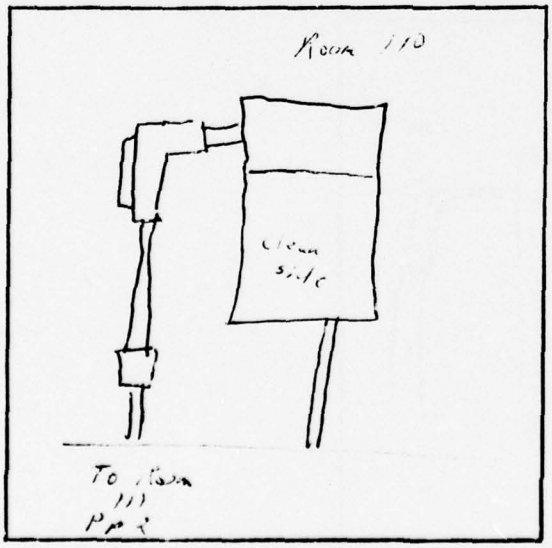
Location: Room 110

Test - Radiate PP2 Room 111, Receive: Room 110, clean side of filter

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	+ 94 db	90 db	102 db above baseline
Meas Lvl	−23	~~90~~ 5 db	26 db max "
Ref 2	+94	85 db	102 db
Reqd Attn			
Meas Attn	117 db	50 db	76 ~~75~~ db

Receiver — NM 12 AT Ailtech 707

Test Item Sketch



REMARKS

Ail Tech 707
10 amp 2 body units with 90 db atten

From Area A to B

Filters are:
Hopkins Engineering Co
San Fernando, Calif
Type 754-3
Part # F 12146
25 amp, 277 v

Test Operators: Hall, Hannum, Nielsen

Test Observers: _____

Type 4
for electrical
filters and conduit

Test Item: Filter R19

CERL Data Sheet

6 oct 1976

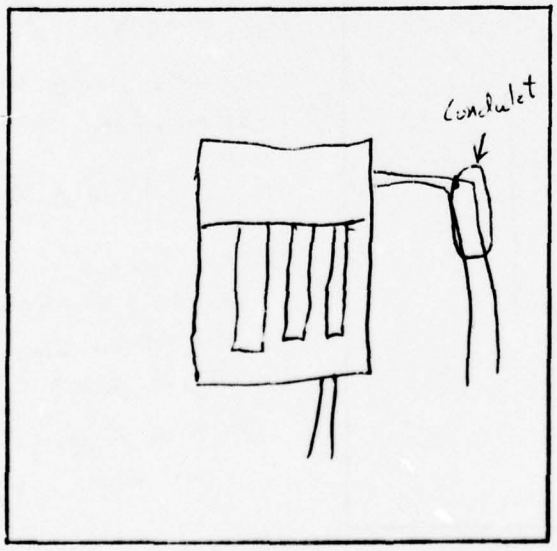
Location: Room 110

Test: Radiate: Room 111, Switchgear 2 Zones A to B

Receive: Room 110, Filter

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	+93 db	99 db	99
Meas Lvl	-25 db	Noise level	18
Ref 2	+72	98	99
Reqd Attn			
Meas Attn	117 db	98+	81

Test Item Sketch



REMARKS

Filters are mounted in clean side

Test Operators: Hall, Hannum, Nielsen

Test Observers: _____

Type 4
for electrical
filters and conduit

Test Item: Filter R20

Location: Room 110

CERL Data Sheet

6 Oct 76

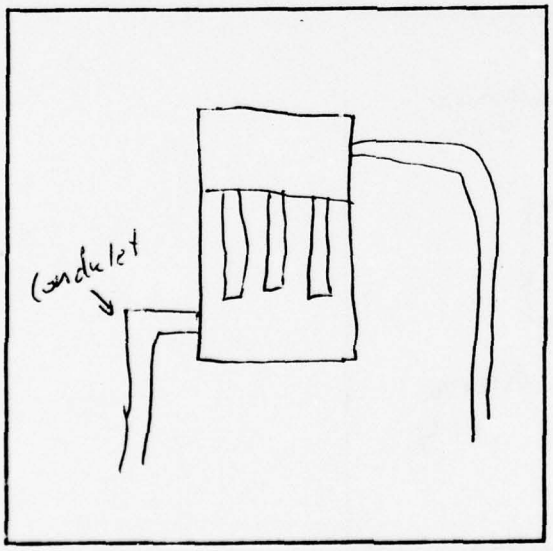
Test: Radiate - Room 111, switch gear 2

Receive - Room 110, Filter

Zones A & B

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	+93db	77 db	99
Meas Lvl	-15db	Noise level	25
Ref 2	92 db	95	99
Reqd Attn			
Meas Attn	107 db	95+	76

Test Item Sketch



REMARKS

Filters are mounted in clean side.

Test Operators: Hall, Hannum, Nielsen

Test Observers: _____

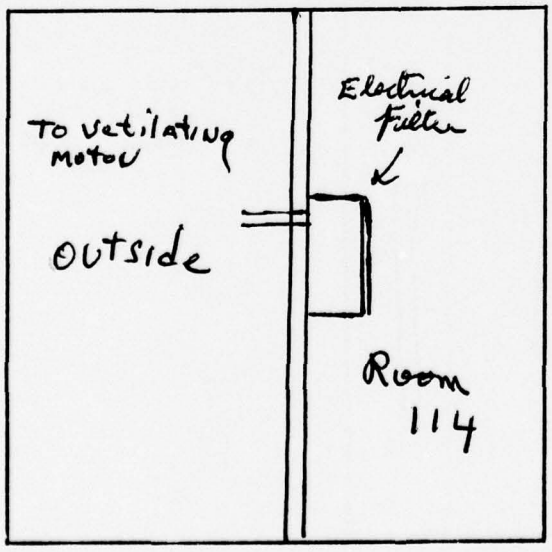
Type 4
for electrical
filters and conduit

CERL Data Sheet

Electrical Filter R22
Room 114 South wall to Outside
September 11, 1976

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-2	70	70
Meas Lvl	∠-90	∠0	∠0
Ref 2	-2	70	70
Reqd Attn			
Meas Attn	>88	>70	>70

Test Item Sketch



REMARKS

Test Operators: STRINGFELLOW RACIOPPI Ford.

Test Observers: _____

Type 4
for electrical
filters and conduit

CERL Data Sheet

Item: RF 23

Not tested

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1			
Meas Lvl			
Ref 2			
Reqd Attn			
Meas Attn			

Test Item Sketch

REMARKS

10 October 1976

First opening for testing is JB 9 in Room 109 JB9 underneath walkway and is relatively inaccessible for test

F. Nielsen

Test Operators: _____

Test Observers: _____

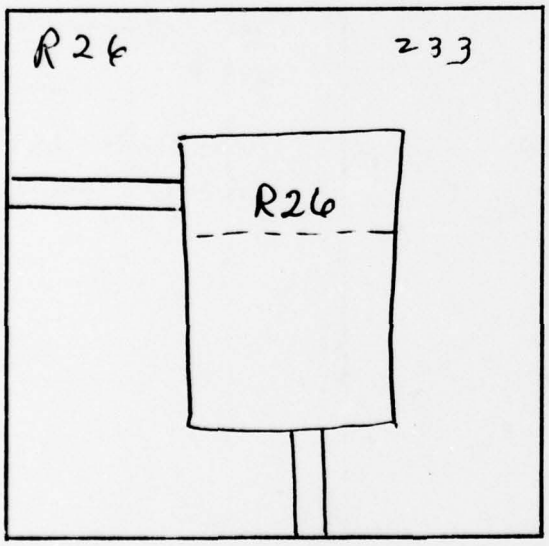
Type 4
for electrical
filters and conduit

CERL Data Sheet

ELECTRICAL FILTER R26
ROOM 111

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	80	80
Meas Lvl	<-90	<0	<0
Ref 2	-5	80	80
Reqd Attn			8
Meas Attn	785	780	780

Test Item Sketch



REMARKS

Test Operators: STRINGFELLOW, FORD, KAVANOE

Test Observers: _____

Type 4
for electrical
filters and conduit

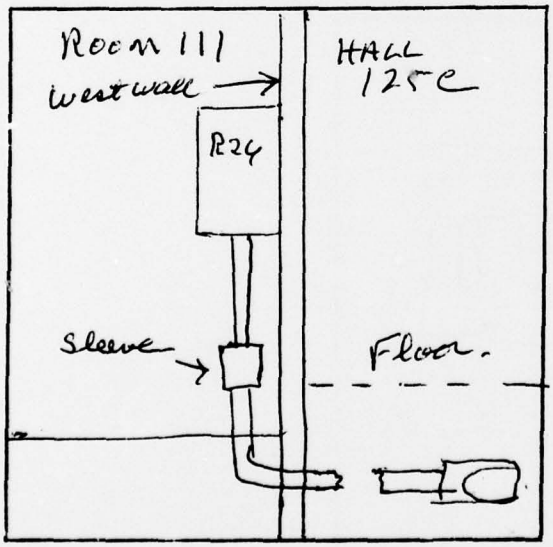
CERL Data Sheet

C 233
R 26

CONDUIT TEST

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	100	70
Meas Lvl	~~X~~ -85	< 20	< 0
Ref 2	-5	100	70
Reqd Attn			
Meas Attn	> 80DB	> 80DB	> 70DB

Test Item Sketch



REMARKS

Test Operators: Stringfellow Racioppi Ladd

Test Observers: _____

Type 4
for electrical
filters and conduit

Test Item - R27 Filter

CERL Data Sheet

6 October 1976

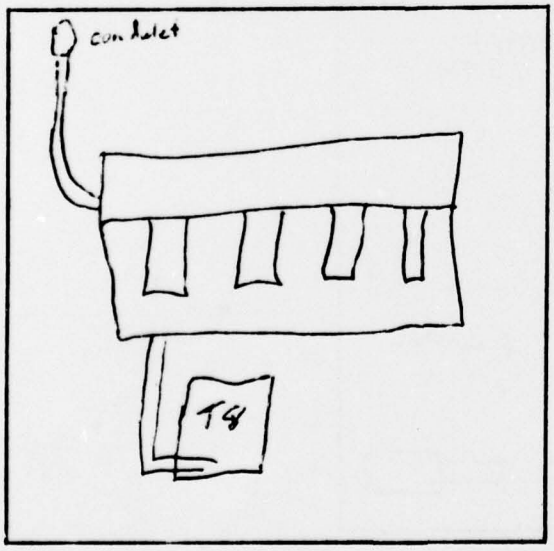
Location - Room 111

Test: Radiate - Filter in 111 Zones B to C

Receive - LP4 in Hallway 125

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	94 db	84 db	97 db
Meas Lvl	-30db noise level	6	8 db
Ref 2	93 db	91	96 db
Reqd Attn	48db	48db	48db
Meas Attn	123 db	78 db	88db

Test Item Sketch



REMARKS

Test Operators: Hall, Hannum, Nielsen

Test Observers: _____

Type 4
for electrical
filters and conduit

CERL Data Sheet

Item: Rm 28

Not tested

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1			
Meas Lvl			
Ref 2			
Reqd Attn			
Meas Attn			

Test Item Sketch

REMARKS 10 October

Test location for receiver is on roof and is relatively inaccessible.

Paul Nielsen

Test Operators: _____

Test Observers: _____

APPENDIX F:

PIPE AND CONDUIT TEST RESULTS

This appendix presents the data sheets for the pipe and conduit tests. The data sheets for the PWS (p 114) and PWR (p 115) pipes are presented first, followed by those for the conduits, in the following order:

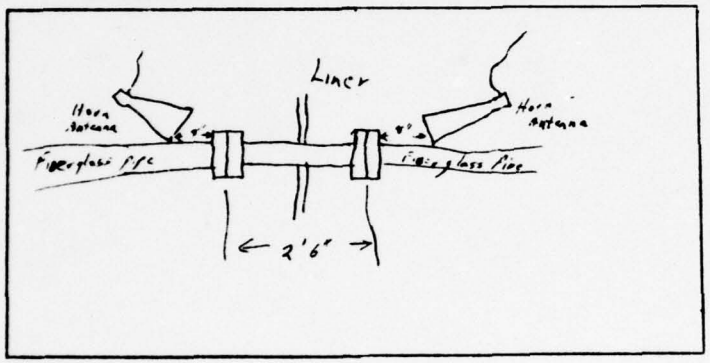
Test Item: PWS
Location:
Date of Test: 9 Oct 1976

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1												105	80
Meas Lvl												95	69
Ref Lvl 2												105	75
Attn Reqd													
Attn Meas												10	6

Test Item Sketch



REMARKS

Test Operators Nielsen, Hall

Test Observers

Test Item: PWR
Location:
Date of Test: 9 Oct 1982

CERL Data Sheet

Type 3
for air duct filters
and pipe filters

Freq	60 Hz	400 Hz	1 kHz	4.5 kHz	9 kHz	10 kHz	200 kHz	1 mHz	10 mHz	100 mHz	500 mHz	2.5 gHz	7 gHz
Ref Lvl 1												105	80
Meas Lvl												90	66
Ref Lvl 2												105	75
Attn Reqd													
Attn Meas												15	11

Test Item Sketch

REMARKS

Test Operators Hall, Nielsen
Test Observers

Type 4
for electrical
filters and conduit

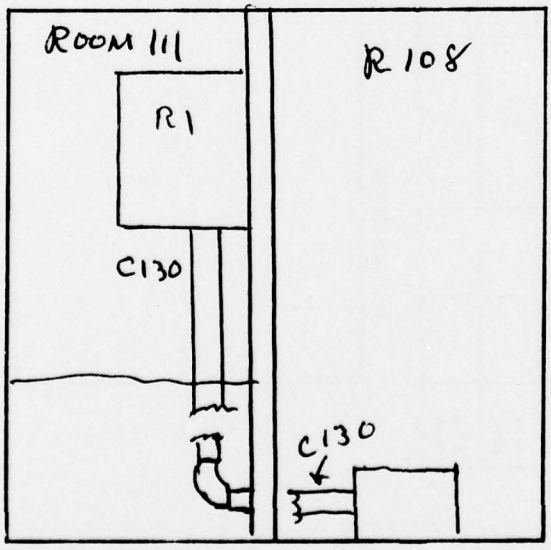
CERL Data Sheet

CONDUIT TEST

C130
R1

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	−5	100	70
Meas Lvl	−85	<20	
Ref 2	−5	100	
Reqd Attn			
Meas Attn	80DB	>80DB	>70DB

Test Item Sketch



REMARKS

Test Operators: String Fellow Bacciappi Jr d

Test Observers: _____

Type 4
for electrical
filters and conduit

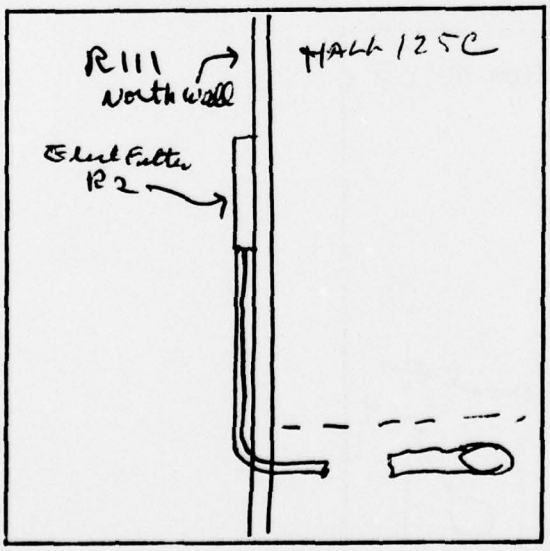
CERL Data Sheet

C 193
R 2

CONDUIT TEST

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	100	70
Meas Lvl	< -85	< 20	< 0
Ref 2	-5	100	70
Reqd Attn			
Meas Attn	> 80 DB	> 80DB	> 70DB

Test Item Sketch



REMARKS

Test Operators: Strumpfellows Racioppi Ford

Test Observers: _____

Type 4
for electrical
filters and conduit

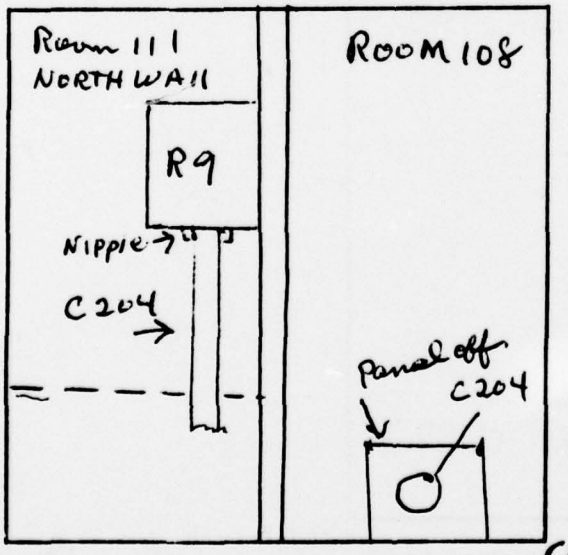
CERL Data Sheet

C 204
R9

CONDUIT TEST

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	100	70
Meas Lvl	∠-85	∠20	∠0
Ref 2	-5	100	70
Reqd Attn			
Meas Attn	>80DB	780DB	770DB

Test Item Sketch



REMARKS

Test Operators: Strong Fellow Racioppi Jan 6

Test Observers: _____

Type 4
for electrical
filters and conduit

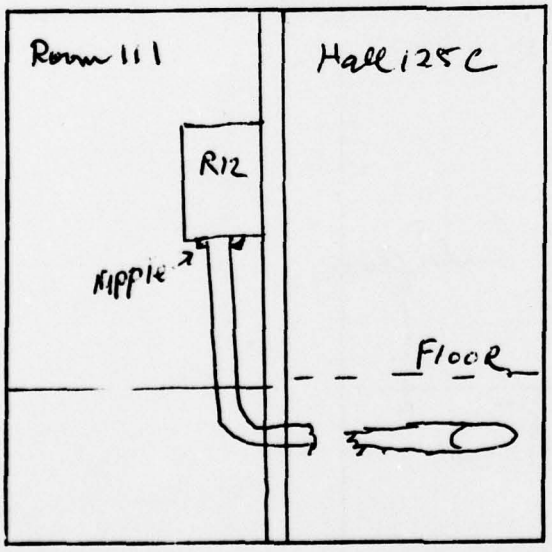
CERL Data Sheet

CONDUIT TEST

C 240
R12

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	100	70
Meas Lvl	< -85	< 20	< 0
Ref 2	-5	100	70
Reqd Attn			
Meas Attn	> 80DB	> 80DB	> 70DB

Test Item Sketch



REMARKS

Test Operators: Strongfellow, Racioppi, Ford

Test Observers: _____

Type 4
for electrical
filters and conduit

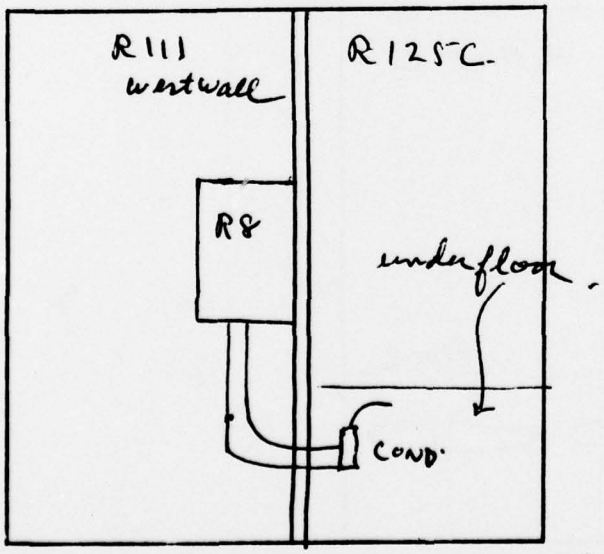
CERL Data Sheet

C 246
R 8

CONDUIT TEST

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	100	70
Meas Lvl	L-85	L 20	L 0
Ref 2	-5	100	70
Reqd Attn			
Meas Attn	> 80	> 80	> 70

Test Item Sketch



REMARKS

Test Operators: Strongfellow, Racioppi, Ford

Test Observers: _____

Type 4
for electrical
filters and conduit

CERL Data Sheet

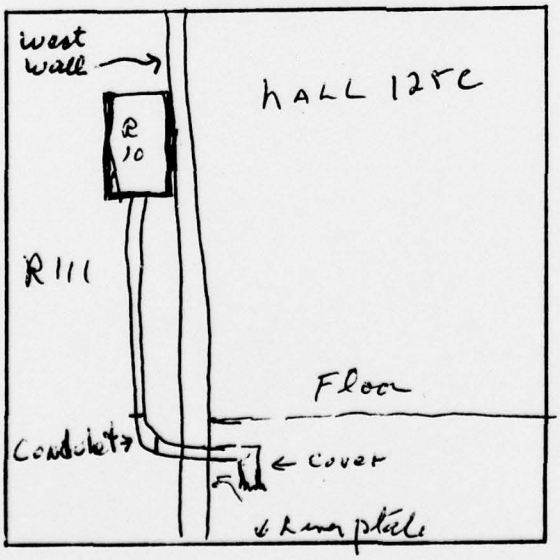
C 24 8

CONDUIT TEST

R 10

Frequency	200 kHz	100 mHz	2.5 gHz
Ref 1	-5	70	70
Meas Lvl	90	0	70
Ref 2	-5	70	70
Reqd Attn			
Meas Attn	785 DB	770 DB	770 DB

Test Item Sketch



REMARKS

Conduit R248

Test Operators: Stanfellow Ramapo Inc!

Test Observers: _____

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